

378.742
N5345
1960/61

**BULLETIN OF THE
UNIVERSITY OF
NEW HAMPSHIRE**

**Graduate School
1960-1961**

University of New Hampshire
Library

Correspondence

Prospective graduate students are invited to correspond with University officials as follows:

Dean of the Graduate School for application forms, the Graduate School catalogue, admissions, graduate status, graduate scholarships, transfer of credits, and programs of study.

Chairmen of Departments for further information and guidance concerning departmental course offerings, individual programs of study, and graduate assistantships.

Director of the Summer Session for information on summer course offerings.

University Alumni Executive for information concerning the Alumni Association.

University Registrar for transcripts of grades earned at the University of New Hampshire.

Director of Placement for information concerning senior or graduate placement.

Catalogue
of the
Graduate School

An Issue
of the
Bulletin of the
University of New Hampshire

University Calendar

1960

Summer Session

June 20	Monday	Registration and first day of classes, eight-week session and first four-week session
July 5	Tuesday	Registration, six-week session
July 6	Wednesday	First day of classes, six-week session
July 18	Monday	Registration and first day of classes, second four-week session
Aug. 14	Friday	Classes end

First Semester

Sept. 6	Tuesday	Last day for application for admission to graduate study for first semester
Sept. 14	Wednesday	First Faculty meeting
Sept. 16	Friday 9 a.m. to 4 p.m.	Registration
Sept. 19	Monday	Classes start, 8:00 a.m.
Nov. 22	Tuesday	Thanksgiving recess starts, 5:30 p.m.
Nov. 28	Monday	Classes resume, 8:00 a.m.
Nov. 29	Tuesday	Last day for filing applications for graduate scholarships for second semester
Dec. 17	Saturday	Christmas recess starts, 12:30 p.m.

1961

Jan. 4	Wednesday	Classes resume, 8:00 a.m. Last day for application for admission to graduate study for second semester
Jan. 23	Monday	Examinations start
Jan. 31	Tuesday	Examinations end

Second Semester

Feb. 6	Monday	Classes start, 8:00 a.m.
Feb. 28	Tuesday	Last day for filing applications for graduate scholarships for academic year 1961-62
April 1	Saturday	Spring recess starts, 12:30 p.m.
April 10	Monday	Classes resume, 8:00 a.m.
May 6	Saturday	Mother's Day, classes end at 11 a.m.
May 12	Friday	Last day for presenting Ph.D. dissertation at Graduate School Office, if degree is to be granted in June
May 26	Friday	Last day for final Ph.D. oral examination, if degree is to be granted in June Last day for presenting completed Master's thesis to Graduate School Office, if degree is to be granted in June
May 29	Monday	Examinations start
May 30	Tuesday	Memorial Day — holiday
June 7	Wednesday	Examinations end
June 11	Sunday	Commencement

TABLE OF CONTENTS

	Page
UNIVERSITY CALENDAR	3
THE BOARD OF TRUSTEES	6
THE GRADUATE FACULTY	7
COMMITTEES OF THE GRADUATE SCHOOL	11
GENERAL INFORMATION	
GENERAL REGULATIONS	12
<p>Admission; Admission to Candidacy for a Degree; Registration; Graduate Credits; Graduate Work in the Summer Session; Graduate Credit for Senior Students; Unclassified Students; Incomplete Grades in the Graduate School; Departmental Requirements; Tuition; Memorial Union Fee; Changes in Rates; Graduate Assistantships; Tuition Scholarships; Hubbard Farms Fellowship in Poultry Science; George F. Dwinell Memorial Fellowship Fund of The New Hampshire Cancer Society, Inc.; Reduced Tuition and Fees for Members of Staff Families; Honorary Fellowships for Visiting Scholars.</p>	
REQUIREMENTS FOR THE MASTER'S DEGREES	17
<p>Residence; Grades; Examinations; Transfer Credits; Thesis; Thesis Regulations.</p>	
REQUIREMENTS FOR THE DOCTOR OF PHILOSOPHY DEGREE	19
<p>Registration; Tuition — Regular Student; Special Research Charge for Doctoral Students; In Absentia; General Requirements; Guidance Committee; The Doctoral Committee; Qualifying Examination; Advancement to Candidacy; Dissertation; Final Examination.</p>	
LIVING FACILITIES	22
COUNSELING CENTER	22
HEALTH SERVICE	22
MEDICAL INSURANCE	23
MEMORIAL UNION	23
PLACEMENT SERVICES	23
THE ALUMNI ASSOCIATION	23

	Page
DEPARTMENTAL REQUIREMENTS AND DESCRIPTION OF COURSES	25
AGRICULTURAL ECONOMICS	25
AGRICULTURAL EDUCATION	26
AGRONOMY	28
ANIMAL SCIENCE	29
BACTERIOLOGY	30
BIOCHEMISTRY	31
BIOLOGY	32
BOTANY	33
CHEMICAL ENGINEERING	35
CHEMISTRY	38
CIVIL ENGINEERING	41
DAIRY SCIENCE	44
ECONOMICS	45
EDUCATION	48
ELECTRICAL ENGINEERING	54
ENGLISH	57
ENTOMOLOGY	59
FORESTRY	60
GOVERNMENT	61
HISTORY	64
HOME ECONOMICS	65
HORTICULTURE	68
LANGUAGES	70
MATHEMATICS	75
MECHANICAL ENGINEERING	80
PHYSICS	81
POULTRY SCIENCE	83
PSYCHOLOGY	84
SOCIOLOGY	87
ZOOLOGY	90

Board of Trustees

HIS EXCELLENCY, GOVERNOR WESLEY POWELL, LL.B., *ex officio*

PERLEY I. FITTS, B.S., COMMISSIONER OF AGRICULTURE, *ex officio*

PRESIDENT ELDON L. JOHNSON, A.B., LL.D., PH.D., *ex officio*

LAURENCE F. WHITTEMORE, M.A., LL.D., President
September 14, 1944 to June 30, 1960
Pembroke, N. H.

AUSTIN I. HUBBARD, B.S., Vice-President
December 20, 1944 to June 30, 1961
Walpole, N. H.

*GEORGE E. COLEMAN, JR., B.S., Secretary
July 1, 1952 to June 30, 1960
Exeter, N. H.

FRANK W. RANDALL, B.S., LL.D.,
July 1, 1936 to June 30, 1960
Portsmouth, N. H.

ERNEST W. CHRISTENSEN, B.S.
July 1, 1940 to June 30, 1961
Dover, N. H.

MARY S. BROWN
December 20, 1944 to June 30, 1963
Center Sandwich, N. H.

MAURICE F. DEVINE, LL.B., LL.D.
December 21, 1949 to June 30, 1962
Manchester, N. H.

GEORGE L. FRAZER
July 1, 1957 to June 30, 1962
Monroe, N. H.

*FORREST M. EATON, B.S.
July 1, 1959 to June 30, 1963
Portsmouth, N. H.

BRADFORD S. BOOTHBY, B.S.
October 14, 1959 to June 30, 1963
Union, N. H.

* Elected by alumni.

The Graduate Faculty

ELDON L. JOHNSON, PH.M., PH.D., President of the University
JOHN F. REED, M.A., PH.D., Dean of the Graduate School, Dean of the College of Liberal Arts, and Professor of Botany
THELMA BRACKETT, A.B., Librarian
ROBERT N. FAIMAN, M.S., PH.D., Dean of the College of Technology and Professor of Electrical Engineering
HAROLD C. GRINNELL, M.S., PH.D., Dean of the College of Agriculture
HARRY A. KEENER, M.S., PH.D., Director of the Agricultural Experiment Station and Professor of Dairy Science
PETER JANETOS, ED.M., PH.D., Director of the Summer Session and Director of Extension

EDWIN S. ALLING, M.ENG., Associate Professor of Civil Engineering
ALEXANDER R. AMELL, PH.D., Associate Professor of Chemistry
RICHARD A. ANDREWS, M.S., PH.D., Assistant Professor of Agricultural Economics
PHILIP S. BARTON, M.ED., Professor of Agricultural Education
STANLEY I. BERGER, PH.D., Assistant Professor of Psychology
SYLVESTER H. BINGHAM, A.M., PH.D., Professor of English
FLETCHER A. BLANCHARD, JR., M.S., Associate Professor of Electrical Engineering
ROBERT L. BLICKLE, M.S., PH.D., Professor of Entomology
HARRY E. BOSTIAN, M.S., PH.D., Assistant Professor of Chemical Engineering
MELVIN T. BOBICK, M.A., PH.D., Assistant Professor of Sociology
EDMOND W. BOWLER, S.B., Professor of Civil Engineering
JAMES R. BOWRING, M.A., PH.D., Professor of Agricultural Economics
PAUL E. BRUNS, M.F., PH.D., Professor of Forestry
LLOYD W. BUHRMAN, PH.D., Associate Professor of Languages
WILBUR L. BULLOCK, M.S., PH.D., Associate Professor of Zoology
LAURENCE J. CAHILL, JR., PH.D., Assistant Professor of Physics
HERBERT A. CARROLL, A.M., PH.D., Professor of Psychology
R. ALBERTO CASAS, A.M., PH.D., Professor of Languages
WILLIAM R. CHESBRO, M.S., PH.D., Assistant Professor of Bacteriology
RONALD R. CLARK, M.ENG., Instructor in Electrical Engineering
WALTER M. COLLINS, M.S., Associate Professor of Poultry Science
NICHOLAS F. COLOVOS, M.S., Research Associate Professor of Dairy Science
JAMES G. CONKLIN, M.S., PH.D., Professor of Entomology
ALAN C. CORBETT, M.S., D.V.M., Associate Professor of Poultry Science
ROBERT W. CORELL, M.S., Assistant Professor of Mechanical Engineering
RALPH H. CRYESKY, M.A., PH.D., Assistant Professor of Languages
ALBERT F. DAGGETT, M.S., PH.D., Professor of Chemistry
G. HARRIS DAGGETT, M.S., PH.D., Associate Professor of English
CHARLES O. DAWSON, M.S., Professor of Civil Engineering
CARROLL M. DEGLER, M.B.A., Professor of Economics
RICHARD S. DEWEY, M.A., PH.D., Professor of Sociology
ROBERT B. DISHMAN, A.M., PH.D., Professor of Government
EDWARD T. DONOVAN, B.S., Professor of Mechanical Engineering
WILLIAM H. DREW, M.S., Associate Professor of Agricultural Economics
WILLIAM R. DUNLOP, D.V.M., V.S., Research Associate Professor of Poultry Science
GERALD M. DUNN, M.S., PH.D., Associate Professor of Agronomy
STUART DUNN, M.S., PH.D., Associate Professor of Botany

OWEN B. DURGIN, M.A., Assistant Professor of Sociology
 RUSSELL EGGERT, M.S., Research Associate Professor of Horticulture
 JAMES C. FAULKNER, M.A., PH.D., Associate Professor of Languages
 JOSEPH P. FORD, M.P.A., Instructor in Government
 GEORGE E. FRICK, M.S., Adjunct Professor of Agricultural Economics
 ALBERT D. FROST, PH.D., Associate Professor of Electrical Engineering
 JAMES A. FUNKHOUSER, PH.D., Professor of Chemistry
 MERRITT A. GIBSON, PH.D., Assistant Professor of Zoology
 JAMES W. GILL, PH.D., Assistant Professor of Poultry Science
 PAUL A. GILMAN, M.S., Associate Professor of Farm Mechanics
 ROBERT C. GILMORE, M.A., PH.D., Assistant Professor of History
 HERBERT W. GRAHAM, PH.D., Lecturer in Zoology
 HELMUT M. HAENDLER, PH.D., Professor of Chemistry
 HARRY H. HALL, PH.D., Professor of Physics
 GEORGE M. HASLERUD, PH.D., Professor of Psychology
 HANS HEILBRONNER, A.M., PH.D., Assistant Professor of History
 WILLIAM G. HENNESSY, A.M., Professor of English
 WILLIAM F. HENRY, M.S., Professor of Agricultural Economics
 PETER L. HEYWORTH, A.B., Instructor in English
 LEROY J. HIGGINS, B.S., Associate Professor of Agronomy
 HAROLD W. HOCKER, JR., M.F., D.F., Assistant Professor of Forestry
 ALBION R. HODGDON, M.S., PH.D., Professor of Botany
 JOHN A. HOGAN, A.M., M.A., PH.D., Professor of Economics
 JOHN T. HOLDEN, M.P.A., M.A., PH.D., Professor of Government
 ROBERT E. HOUSTON, PH.D., Assistant Professor of Physics
 JOHN B. HRABA, M.ENG., PH.D., Associate Professor of Electrical Engineering
 BERTRAM HUSCH, M.F., PH.D., Associate Professor of Forestry
 HAROLD A. IDDLIS, M.S., PH.D., Professor of Chemistry
 CHARLES A. JELLISON, JR., M.A., PH.D., Assistant Professor of History
 FREDERICK M. JERVIS, M.A., Lecturer in Psychology
 ARTHUR W. JOHNSON, M.B.A., C.P.A., Professor of Business Administration
 PAUL R. JONES, PH.D., Assistant Professor of Chemistry
 TENHO S. KAUPPINEN, M.S., Associate Professor of Mechanical Engineering
 BRIAN R. KAY, M.A., PH.D., Associate Professor of Psychology
 WILLIAM L. KICHLINE, M.S., Professor of Mathematics
 R. A. KILPATRICK, PH.D., Lecturer in Botany
 JOHN T. KITCHIN, PH.D., Associate Professor of Horticulture
 DAVID C. KNAPP, A.M., PH.D., Associate Professor of Government
 WAYNE S. KOCH, ED.M., Professor of Education
 HENRY G. KUIVILA, M.A., PH.D., Professor of Chemistry
 ALLAN A. KUUSISTO, A.M., PH.D., Professor of Government
 IRVIN LAVINE, PH.D., Professor of Chemical Engineering
 MARCEL E. LAVOIE, M.S., PH.D., Assistant Professor of Zoology
 WILLIAM R. LEE, JR., M.S., PH.D., Assistant Professor of Entomology
 CHARLES H. LEIGHTON, M.A., Instructor in Languages
 ARNO K. LEPKE, PH.D., Associate Professor of Languages
 JOHN A. LOCKWOOD, M.S., PH.D., Professor of Physics
 MARGARET E. LOUGHLIN, M.S., Assistant Professor of Biochemistry
 GLORIA G. LYLE, PH.D., Instructor in Chemistry
 ROBERT E. LYLE, JR., M.S., PH.D., Professor of Chemistry
 JOHN C. MAIRHUBER, M.A., PH.D., Assistant Professor of Mathematics
 THOMAS O. MARSHALL, JR., ED.M., ED.D., Professor of Education
 PHILIP M. MARSTON, M.A., Professor of History
 MAX S. MAYNARD, B.A., Associate Professor of English
 ELWYN M. MEADER, M.S., Research Associate Professor of Horticulture
 DONALD W. MELVIN, M.ENG., Assistant Professor of Electrical Engineering

CARLTON P. MENGE, M.A., PH.D., Associate Professor of Education
 THEODORE G. METCALF, PH.D., Associate Professor of Bacteriology
 EDMUND G. MILLER, M.A., PH.D., Assistant Professor of English
 GEORGE M. MOORE, M.S., PH.D., Professor of Zoology
 HERBERT C. MOORE, M.S., Associate Professor of Dairy Science
 KENNETH S. MORROW, M.S., Professor of Dairy Science
 LYMAN MOWER, PH.D., Assistant Professor of Physics
 JOHN E. MULHERN, PH.D., Associate Professor of Physics
 M. EVANS MUNROE, SC.M., PH.D., Professor of Mathematics
 JOSEPH B. MURDOCH, M.S., Associate Professor of Electrical Engineering
 CHARLOTTE C. NAST, M.A., PH.D., Associate Professor of Botany
 MELVILLE NIELSON, M.A., PH.D., Associate Professor of Sociology
 WILLIAM B. NULSEN, M.S., Professor of Electrical Engineering
 ROBERT H. OWENS, M.A., PH.D., Associate Professor of Mathematics
 STUART H. PALMER, M.A., PH.D., Assistant Professor of Sociology
 CLIFFORD S. PARKER, A.M., PH.D., Professor of Languages
 RUTH M. PETERS, M.A., PH.D., Associate Professor of Mathematics
 NOBEL K. PETERSON, M.S., PH.D., Associate Professor of Agronomy
 MARION H. PETTIBONE, M.S., PH.D., Associate Professor of Zoology
 FRANK L. PILAR, PH.D., Assistant Professor of Chemistry
 ALLAN B. PRINCE, PH.D., Professor of Agronomy
 AVERY E. RICH, M.S., PH.D., Professor of Botany
 MATHIAS C. RICHARDS, PH.D., Professor of Botany
 RICHARD C. RINGROSE, PH.D., Professor of Poultry Science
 SHELDON R. ROEN, M.A., PH.D., Assistant Professor of Psychology
 OWEN M. ROGERS, M.S., PH.D., Assistant Professor of Horticulture
 SAM ROSEN, A.M., PH.D., Associate Professor of Economics
 SHEPLEY L. ROSS, M.A., PH.D., Associate Professor of Mathematics
 DOUGLAS G. ROUTLEY, M.S., PH.D., Assistant Professor of Biochemistry
 EVERETT B. SACKETT, M.A., PH.D., Professor of Education
 PHILIP J. SAWYER, M.S., PH.D., Assistant Professor of Zoology
 PAUL E. SCHAEFER, M.S., PH.D., Associate Professor of Zoology
 RICHARD W. SCHREIBER, M.S., PH.D., Assistant Professor of Botany
 J. HOWARD SCHULTZ, M.A., PH.D., Associate Professor of English
 JOSEPH E. SHAFER, M.A., PH.D., Professor of Economics
 J. GORDON SHAW, M.A., PH.D., Assistant Professor of Sociology
 STANLEY R. SHIMER, M.S., Professor of Biochemistry
 RUSSELL R. SKELTON, S.M., Professor of Civil Engineering
 WINTHROP C. SKOGLUND, M.S., PH.D., Professor of Poultry Science
 LAWRENCE W. SLANETZ, PH.D., Professor of Bacteriology
 ANNA LIGHT SMITH, M.A., PH.D., Professor of Home Economics
 GERALD L. SMITH, M.S., Associate Professor of Animal Science
 WILLIAM W. SMITH, M.S., PH.D., Professor of Horticulture
 CLARK L. STEVENS, M.F., PH.D., Professor of Forestry
 E. HOWARD STOLWORTHY, B.S., Professor of Mechanical Engineering
 RICHARD G. STROUT, M.S., Instructor in Poultry Science
 LEWIS C. SWAIN, M.F., Professor of Forestry
 EMERY F. SWAN, PH.D., Associate Professor of Zoology
 ARTHUR E. TEERI, M.S., PH.D., Professor of Biochemistry
 LORING V. TIRRELL, M.S., Professor of Animal Science
 CARROLL S. TOWLE, PH.D., Professor of English
 HARRY J. TURNER, M.S., Lecturer in Zoology
 DALE S. UNDERWOOD, M.A., PH.D., Associate Professor of English
 RUSSELL L. VALENTINE, M.S., M.E., Associate Professor of Mechanical Engineering
 OLIVER P. WALLACE, M.F., PH.D., Associate Professor of Forestry

JOHN S. WALSH, M.A., Professor of Languages
KARL S. WEBSTER, M.S., Assistant Professor of Mechanical Engineering
ROBERT G. WEBSTER, M.A., Professor of English
CHARLES M. WHEELER, JR., M.S., PH.D., Associate Professor of Chemistry
ALDEN L. WINN, S.M.E.E., Professor of Electrical Engineering
RUTH J. WOODRUFF, A.M., PH.D., Professor of Economics
PAUL A. WRIGHT, PH.D., Associate Professor of Zoology
OSWALD T. ZIMMERMAN, M.S.E., PH.D., Professor of Chemical Engineering
J. HAROLD ZOLLER, PH.D., Professor of Civil Engineering

Committees of the Graduate School

Graduate Council

ELDON L. JOHNSON, PH.M., PH.D., President of the University

JOHN F. REED, M.A., PH.D., Dean of the Graduate School, *Chairman*

HERBERT A. CARROLL, A.M., PH.D., Professor of Psychology

HARRY H. HALL, PH.D., Professor of Physics

HAROLD A. IDDES, M.S., PH.D., Professor of Chemistry

EVERETT B. SACKETT, M.A., PH.D., Professor of Education

PHILIP M. MARSTON, M.A., Professor of History, *Secretary*

GEORGE M. MOORE, M.S., PH.D., Professor of Zoology

CARROLL S. TOWLE, PH.D., Professor of English

Committee on Graduate Scholarships

G. HARRIS DAGGETT, M.S., PH.D., Associate Professor of English

EDWARD T. DONOVAN, B.S., Professor of Mechanical Engineering

STUART DUNN, M.S., PH.D., Associate Professor of Botany, *Chairman*

JOHN T. HOLDEN, M.P.A., M.A., PH.D., Professor of Government

General Information

The Graduate School, which has offered instruction since 1903, has for its objective the bringing together of faculty and qualified students in a spirit of scholarship and research. The graduate student is given opportunity to specialize in some field of knowledge, and to develop a maturity of thought and attitude toward his professional field, so that both his professional and his cultural life are enhanced.

The work of the Graduate School is under the general direction of the graduate faculty. The Dean of the Graduate School is responsible for the administration of the regulations and requirements pertaining to admission, conduct of work, the granting of advanced degrees, and other pertinent matters.

Graduate programs are offered by the following departments: Agricultural Economics, Agronomy, Animal Science, Bacteriology, Biochemistry, Biology, Botany, Chemical Engineering, Chemistry, Civil Engineering, Dairy Science, Electrical Engineering, Entomology, Forestry, Home Economics, Horticulture, Mathematics, Mechanical Engineering, Physics, Poultry Science, and Zoology leading to the Master of Science degree; Economics, English, Government, History, Languages, Mathematics, Psychology, and Sociology leading to the Master of Arts degree; Education leading to the Master of Education degree; and Agricultural Education leading to the Master of Agricultural Education degree. There is also a program leading to the Master of Science for Teachers degree in both the Chemistry and Mathematics departments.

Graduate programs leading to the degree of Doctor of Philosophy are offered in the following departments: Botany, Chemistry, Horticulture, and Zoology.

Graduate students are defined as those who meet the requirements for admission to the Graduate School (see Rules and Regulations under Admission), and are registered for an approved program for graduate credit.

GENERAL REGULATIONS

ADMISSION. Admission to the Graduate School may be granted to graduates of all colleges and universities of approved standing, provided their undergraduate records are satisfactory. Before entering upon graduate work the applicant must present evidence that he has had the necessary prerequisite training which will enable

him to pursue with benefit the courses desired. A candidate for admission must have had a cumulative undergraduate record of not less than a 2.5 grade point average*, or the equivalent, for his undergraduate program of study. In addition the candidate for admission may be required to take an achievement test, where the department in which the candidate plans to do his work so requires. These general requirements for admission to the Graduate School are in addition to the special requirements set up by individual departments or to those of the program leading to the Master of Science for Teachers degree that presupposes certification as a teacher or its equivalent. For the individual departmental requirements, see the description under the departmental offerings in this bulletin.

A student who desires to register for graduate study must submit to the Dean of the Graduate School the official application for admission to graduate study. Forms for this purpose may be obtained by writing to the Dean of the Graduate School, University of New Hampshire, Durham, New Hampshire. The application must be accompanied by two official transcripts of the student's undergraduate work and of any previous graduate work. Transcripts of applicants who are admitted to graduate study become a permanent part of the University files and will not be returned.

Applications for admission to the Graduate School should be submitted before September 1 for the First Semester, before May 15 for the Summer Session, and before January 1 for the Second Semester to guarantee action before the respective registration days. Applications will be accepted after the dates mentioned above provided that the applications are accompanied by complete official transcripts; but it may be necessary in such instances to postpone the evaluation of credentials and the determination of requirements until after the registration period.

All regularly enrolled graduate students must have a medical history and physical examination report on file with the Director of the University Health Service. Recent graduates of the University of New Hampshire need not file a new set of reports upon being admitted to the Graduate School. Others should procure the proper forms from the Dean of the Graduate School.

ADMISSION TO CANDIDACY FOR A DEGREE. Admission to the Graduate School does not imply admission to candidacy for a degree. No graduate student is admitted to candidacy for a degree until he has been in residence a sufficient time to enable his instructors to judge of his ability to carry on graduate work. Generally this

* On grading scale of A equals 4.0, B equals 3.0, C equals 2.0, D equals 1.0.

period of time shall be not less than that required for the completion of 12 credits of graduate work for the Master's Degree, and the passing of the qualifying examination and the completion of the language requirements for the Ph.D. degree. Admission to candidacy for a degree will be determined by the Dean upon the recommendation of the department concerned. The student will be notified by the Dean, in writing, of the decision made.

REGISTRATION. A student admitted to graduate study must have his program approved by the chairman of his department or of his guidance committee and the Dean of the Graduate School. Registration is held prior to the beginning of classes each semester and on the first day of the Summer Session. Please consult the calendar on page 3 of this bulletin for the current dates of registration.

The maximum graduate load allowed is 16 semester credits for a regular semester and seven credits for a six-week Summer Session. Only under unusual circumstances will excess credits be allowed, and then only with the approval of the Dean of the Graduate School.

GRADUATE CREDITS. Graduate credits may be earned only in courses numbered from 51 through 199, and in the thesis, but graduate credits will not be given in any courses so numbered which are open to freshmen or sophomores.

GRADUATE WORK IN THE SUMMER SESSION. Graduate students who desire to do a part of their work during the Summer Session of the University will find graduate courses offered in many departments. Credit in appropriate courses may be used in fulfilling the requirements for an advanced degree. For complete information on the Summer Session see the Summer Session issue of the Bulletin of the University of New Hampshire.

GRADUATE CREDIT FOR SENIOR STUDENTS. Qualified senior students in the University of New Hampshire may be admitted to the Graduate School, and must have been admitted before taking courses for graduate credit. Such seniors may not substitute courses for which they registered in an undergraduate program for those for which they registered in a graduate program.

UNCLASSIFIED STUDENTS. Students holding the baccalaureate degree who have not been admitted to the Graduate School, but who wish to register for graduate courses, must receive the approval of the Dean of the Graduate School and of the instructor concerned.

INCOMPLETE GRADES IN THE GRADUATE SCHOOL. An incomplete grade in the Graduate School must be made up within a year after the course was to have been completed. This rule does not apply to the completion of the thesis.

DEPARTMENTAL REQUIREMENTS. The student must meet the special requirements of the department in which he is doing his graduate work and his program must be approved by his adviser and the Dean of the Graduate School. For these special requirements see the department statements in this bulletin.

TUITION.* The tuition is \$300 a year for residents of New Hampshire, and \$700 a year for non-residents.

Any student registering for eight credits or more per semester will pay the full semester tuition. Any student registering for fewer than eight credits per semester shall pay \$15.00 per credit hour. In certain instances Graduate Assistants may be exempted from payment of tuition. Tuition for predoctoral students is stated in the section of this bulletin devoted to the requirements of the Doctor of Philosophy degree.

MEMORIAL UNION FEE. An assessment of \$6.00 per semester must be paid by each student.

CHANGES IN RATES. The University reserves the right to adjust charges for such items as tuition, board, and room rent from time to time. Such changes will be held to a minimum and will be announced as far in advance as feasible.

GRADUATE ASSISTANTSHIPS. Approximately sixty graduate assistantships are available each year. Such assistantships are awarded only to superior students. The re-appointment of a Graduate Assistant is contingent on the maintenance of a high level of scholarship. The service required of the Graduate Assistant may be in the nature of (a) teaching assistance, (b) research assistance, or (c) general service.

Inquiries regarding assistantships should be addressed to the chairman of the department concerned.

There are two categories of regular assistantships available. The recommended conditions of employment for each category are shown below:

* For tuition rates in Summer Session see Summer Session catalogue. For tuition rates for extension see extension course announcements. Tuition charges are those of the time this catalogue went to press. They are subject to change without further notice.

I. \$1600 for the academic year for 20 hours of service per week. Normal academic program: 9 semester hours per semester. Exemption from payment of tuition may be granted for the academic year and the following Summer Session on recommendation of the department chairman.

II. \$2240 (10 months at \$160, 2 months at \$320 for the fiscal year for 20 hours of service per week during 9 months, 44 hours per week for two months, with one month of vacation. Normal academic program: 9 semester hours per semester for two semesters. Exemption from payment of tuition for the regular academic year may be granted on the recommendation of the department chairman.

In addition to those already mentioned, in several departments there are assistantships which are supported by sponsored research projects.

TUITION SCHOLARSHIPS. Up to twenty superior students may be granted exemption from tuition. These awards are subject to the maintenance of a high scholastic record in the Graduate School and may be revoked at the end of any semester if the student does not merit such exemption for the subsequent semester. Foreign students will be considered for scholarship awards. Applicants are required to submit an application on a special form available at the Office of the Graduate School.

HUBBARD FARMS FELLOWSHIP IN POULTRY SCIENCE. This fellowship is provided through the generosity of Hubbard Farms, Inc., of Walpole, N. H. The grant is made in support of the graduate and research programs of the Department of Poultry Science. The fellowship is awarded annually to a student who has been admitted to the Graduate School for major work in poultry science and who has demonstrated high scholastic ability as an undergraduate, and is in need of financial assistance. If the student maintains high scholastic standing during his first year of graduate study, the award may be continued during the remainder of his graduate study at the University. The selection of the recipient of this award will be made by a committee composed of the Chairman of the Department of Poultry Science, the Dean of the College of Agriculture, and the Dean of the Graduate School. Applications for this fellowship should be directed to the Dean of the Graduate School.

GEORGE F. DWINELL MEMORIAL FELLOWSHIP FUND OF THE NEW HAMPSHIRE CANCER SOCIETY, INC. This fund is provided, on a yearly basis, to promote the interest of young people in investigative work on growth. Selection of the recipients of these awards

is determined by a University committee. Application should be directed to the Dean of the Graduate School.

REDUCED TUITION AND FEES FOR MEMBERS OF STAFF FAMILIES. The immediate families of members of the University staff may register as full or part-time students in the Graduate School at one-half the current tuition or course rate. They are required, however, to pay the full research fee, if doctoral students.

HONORARY FELLOWSHIPS FOR VISITING SCHOLARS. Properly qualified scholars, who may desire temporarily the privileges of the library and research facilities of the University, and who are not candidates for a degree may, upon recommendation of the Dean of the Graduate School and the approval of the President of the University, be appointed Honorary Fellows without stipend. Honorary Fellows shall not be required to pay any charges except, possibly, the cost of unusually expensive supplies or equipment.

REQUIREMENTS FOR THE MASTER'S DEGREES

For the degrees of Master of Arts, Master of Science, and Master of Agricultural Education, at least 30 credits must be earned, including a minimum of 18 credits in courses, or thesis, numbered from 101 through 199. The major department will prescribe for its students the courses which make up the degree program. See departmental statements for further details on requirements.

The Master of Science for Teachers degree is designed for the experienced and certified teacher who is interested in improving his understanding of the subject matter that he teaches. Thirty credits must be earned and a comprehensive final examination successfully passed. A departmental guidance committee plans the program, subject to the approval of the Dean of the Graduate School and a special committee of the Graduate Faculty; it also administers the final examination.

The requirements for the Master of Education, somewhat different from those above, are described on page 48.

RESIDENCE. A student will normally spend at least one academic year, or the equivalent, on the degree. No more than 12 credits, not including thesis, may be earned off campus. Of these 12, only 6 may be from another graduate school.

All graduate work for any Master's degree must be completed in not more than eight years from the time of registration for the first work taken for the degree.

GRADES. Students in the Master's degree programs must earn a grade of A or B in all courses for which a letter grade is given. The grade of Cr. (credit) is given for the thesis. Any graduate student who receives a grade of below B in nine or more credits will be required to withdraw from the Graduate School.

EXAMINATIONS. In any department or program requiring a final examination for the Master's degree, the examination may be oral, written, or both. A candidate will be permitted only two opportunities to take the final examinations for the Master's degree, and the time of these examinations will be at the convenience of the department concerned, except that all such examinations must be given at least two weeks before the Commencement date in the year in which the degree is to be conferred. Further regulations governing the final written examination, when required, will be made by the department concerned, subject to the approval of the Dean of the Graduate School. Oral examining committees, when required and not otherwise provided for, will be appointed by the Dean of the Graduate School upon the recommendation of the department concerned. The Dean of the Graduate School is, *ex officio*, a member of all examining committees.

TRANSFER CREDITS. A student may present for credit a maximum of six credits earned at another graduate school provided that these credits are of a grade of at least B or the equivalent. These will be applied toward the degree only if approved by the major department and the Dean of the Graduate School.

THESIS. A thesis may be required of candidates for the Master of Arts or the Master of Science degrees. Consult the departmental statement for thesis requirements.

The thesis must be approved by a committee of three, comprising the instructor under whose direction it was written and two other members of the Graduate Faculty selected by the department chairman and approved by the Dean of the Graduate School.

Each department will determine the date when the candidate must submit for approval a statement of the subject of the thesis and the date when the thesis must be completed.

The number of thesis credits may vary from six to ten, subject to the approval of the student's adviser.

No thesis credit shall be given until the completed thesis has been approved by the committee on the thesis. No letter grade shall be given for the thesis, but its satisfactory acceptance will be recorded with a Cr. (credit).

THESIS REGULATIONS. The student should obtain from the Graduate School office the latest mimeographed regulations for the form and typing of theses.

Whenever a thesis is printed, it must be designated as having been accepted as a master's thesis by the University of New Hampshire.

Two copies of the approved thesis, ready for binding, shall be turned in to the Graduate School office not less than two weeks before Commencement, together with a receipt for the binding fee from the University Bookstore. Most departments require one copy of the thesis in addition to the above-mentioned two copies. (See departmental requirements in this bulletin.)

REQUIREMENTS FOR THE DOCTOR OF PHILOSOPHY DEGREE

The degree of Doctor of Philosophy is conferred on qualified candidates who have passed an oral or written examination on the subject matter of their field of study, who have completed an original investigation in this field and have embodied the results in an acceptable dissertation, and who have passed on oral examination in defense of the dissertation. The degree of Doctor of Philosophy is essentially a research degree. It is not given merely for the completion of course credits. Graduate programs leading to the degree of Doctor of Philosophy are given by the Departments of Botany, Chemistry, Horticulture, and Zoology.

REGISTRATION. All resident predoctoral students must register each semester until requirements for the degree have been completed. The minimum requirement for the doctorate is three years beyond the bachelor's degree. Resident graduate work done at other universities may be counted toward the minimum requirement upon approval of the Guidance Committee and the Dean of the Graduate School, but one full academic year must be in residence at the University of New Hampshire. In individual cases, the major department and the Dean of the Graduate School may grant permission to pursue the research for the dissertation at another institution where access to special facilities may be advantageous.

TUITION* — REGULAR STUDENT. The tuition is \$300 a year for residents of New Hampshire, and \$700 a year for non-residents. Any student registering for eight credits or more per semester must

* Tuition charges are those of the time that this catalogue went to press. They are subject to change without further notice.

pay full tuition. In pursuing a program of fewer than eight credit hours per semester, he shall pay at the rate of \$15 per credit hour. In certain instances, graduate assistants may be exempted from payment of tuition, during the academic year and the following summer period.

SPECIAL RESEARCH CHARGE FOR DOCTORAL STUDENTS. A doctoral student who is registered for fewer than eight credits and is pursuing research for the dissertation shall pay by the credit hour, plus a research charge of \$50 a semester. If registered for research only, the charge of \$50 a semester will be applicable and will carry with it the privilege of attending seminars.

IN ABSENTIA. When a doctoral student completes his requirements *in absentia*, a charge of \$50 for the privilege of taking the final examination must be paid six weeks before the conferring of the degree.

GENERAL REQUIREMENTS. A student working for the Ph.D. degree must earn grades of A or B in all the courses required by his guidance committee. Certain courses may be taken for audit. A grade of Cr. (credit) is given for the completed dissertation.

GUIDANCE COMMITTEE. When the student declares his intention to proceed to candidacy for the degree of Doctor of Philosophy, the department of intended major concentration shall notify the Dean of the Graduate School, who then, upon recommendation of the department, will appoint a guidance committee. This committee will assist the student in outlining his program and in preparing him for his qualifying examination. To prepare him for the qualifying examination and successful pursuit of his research and course work, the guidance committee may require him to take additional course work, with or without credit.

THE DOCTORAL COMMITTEE. At the time of application by the student for the qualifying examination, a doctoral committee will be appointed to supervise the qualifying and final examinations and to pass on the dissertation. This committee shall be nominated by the department of major concentration and appointed by the Dean of the Graduate School. It shall consist of a minimum of five members, usually three from the major department and two from related departments, and the Dean of the Graduate School, *ex officio*.

QUALIFYING EXAMINATION. The qualifying examination may be written or oral, or both. This examination will test: (1) the student's general knowledge in his major and minor work, and (2) his fitness for engaging in research, particularly in the subject pro-

posed for the dissertation. The results of the examination will be communicated by the chairman of the major department to the Dean of the Graduate School.

ADVANCEMENT TO CANDIDACY. The student may not be advanced to candidacy for the Ph.D. until he has passed the qualifying examination and has completed the requirements for foreign languages to the satisfaction of the major department. The proposed subject of the student's dissertation must be declared at the time of application for advancement to candidacy. Resident full-time members of the University of New Hampshire faculty with rank of Assistant Professor or higher may not be admitted to candidacy for the Ph.D. at this University.

DISSERTATION. The dissertation must be a mature and competent piece of writing, a contribution to knowledge, embodying the results of significant and original research.

A copy of the completed dissertation must be supplied to the Dean of the Graduate School and to the members of the examining committee two weeks before the final examination date. Following the examination and two weeks prior to Commencement, two copies of the approved thesis, ready for binding, shall be turned in to the Graduate Office, together with a receipt for the binding fee from the University Bookstore. Publication of the dissertation by University Microfilms will be required, and the cost will be assumed by the student. If the material presented in the dissertation is published in a journal of the field, it should be designated as having been accepted as a doctoral dissertation by the University of New Hampshire.

FINAL EXAMINATION. The final oral examination is conducted by the doctoral committee and is intended to give the candidate an opportunity to defend his dissertation. A written final examination, on subject matter not covered in the qualifying examination, may also be required. This written examination is conducted by the major department. The final examinations must be completed at least two weeks prior to the date of receiving the degree. After consultation with the major department, the Dean may appoint, for participation in the final oral examination, additional members of the faculty under whom the student has worked. The doctoral committee alone shall decide on the merits of the candidate's performance by a majority vote.

LIVING FACILITIES

HOUSING. The University operates one small residence hall for graduate students. Room assignments to this hall are made in the order of receipt of the application. Requests for applications for rooms in the Graduate House or for information concerning other available housing should be made directly to the Manager of University Housing, Thompson Hall. Every attempt will be made to secure housing for graduate students.

BOARD. The University operates on a self-service basis a modern, well-appointed dining hall. Regular weekly board and cafeteria service are provided at approximately \$12.

COUNSELING CENTER

The Counseling Center offers personal counsel to those students who experience problems of emotional adjustment.

HEALTH SERVICE

The University Health Service, located in Hood House, is devoted to the protection, improvement, and maintenance of student health. Graduate students carrying 8 or more credits, and graduate assistants, are eligible for treatment. A well-equipped out-patient clinic for diagnosis and treatment of ambulatory patients and a modern hospital of 26 beds, with private and semi-private rooms, wards, and an isolation division for communicable diseases, are constantly available for students who require medical or surgical care. Registered nurses are on duty at all times. Hood House is open 24 hours daily during the periods when school is in session. Individual health guidance is given through personal conferences with the University Physician.

Injury and illness which require hospital confinement other than in Hood House, services of specialists, operations, ambulance service, special nurse, or special prescriptions are at the expense of the student. Bed patients at Hood House are charged \$3.00 per day. Office hours of the University Physician are from 9:00 a.m. to 4:00 p.m. daily except Saturdays and Sundays.

Student health insurance is available to graduate students, and is recommended.

MEDICAL INSURANCE

In addition to the health service available through Hood House, group accident and sickness insurance giving 12 months' coverage is available to students at the University. This insurance coverage is designed to supplement the program of the University. Complete details may be had on application to the Business Office, University of New Hampshire.

MEMORIAL UNION

The University's Memorial Union, which began operations in the fall of 1957, has become a "community center" for students and faculty in the very broadest sense. The Memorial Union was especially designed to fulfill three worthy functions on the UNH campus: a living memorial to the men and women of the State of New Hampshire who have served in our armed forces, a college union, and a state-wide conference center. With its extensive and well-planned facilities, it serves as a focal point of all extra-curricular activities on the campus.

PLACEMENT SERVICES

The placement services of the Testing and Placement Service are available to all degree candidates who have completed at least 12 hours of graduate work at the University of New Hampshire.

THE ALUMNI ASSOCIATION

Those individuals who have received an advanced degree from the University of New Hampshire automatically become members of the Alumni Association. The present membership of the Association exceeds 19,000 men and women who represent New Hampshire College and University of New Hampshire classes from 1890 to 1958. Alumni reside in every state of the union as well as in many foreign countries.

Governed by a Board of Directors of 15 elected and 3 *ex-officio* members, the alumni are organized by classes and clubs. Class reunions are held annually in June in Durham. An annual Homecoming Day in the fall provides opportunity for alumni to return to Durham while the University is in session. A football game with a traditional rival, a chicken barbecue, and a reunion

with former classmates and friends are the outstanding features of Homecoming Day. Other alumni gatherings on campus are also scheduled from time to time during the academic year. Every year 41 UNH Alumni Clubs throughout the United States hold from one to six meetings each. The clubs' annual meetings are held simultaneously on or near "Ben Thompson Day", April 22. A monthly magazine, *The New Hampshire Alumnus*, issued nine times a year, circulates news of students, faculty, alumni, and the University to Association subscribers. From Alumni Offices in Alumni House on Garrison Avenue, the Association's activities are directed by a permanent Alumni Executive.

Departmental Requirements and Description of Courses

If the numerals designating a course running through both semesters are connected by a hyphen, the first semester's work, or its equivalent, is a prerequisite to the second. If the numerals are separated by a comma, properly qualified students may take the second semester's work without having had the first.

Courses numbered 51 through 99 are open to graduate and advanced undergraduate students. Courses numbered from 101 through 199 are open only to those admissible to graduate study.

The Graduate School reserves the right not to offer an announced course when valid reasons arise.

AGRICULTURAL ECONOMICS

WILLIAM F. HENRY, *Chairman*

Admission to graduate study in Agricultural Economics may be granted those who have satisfied the requirements for admission to the Graduate School and present evidence of satisfactory training in the fields of agriculture and economics. Normally, this will mean a degree from a college of agriculture and 9 or more credits in economics, including Agricultural Economics, as evidence of aptitude for advanced training in the field. The requirement of a degree from a college of agriculture may be waived in the case of a mature student who has a degree in a field other than agriculture (providing he presents evidence of a knowledge of farm production or marketing practice), upon approval of the Chairman of the Department. Candidates for the Master's degree will be required to pass a final examination and present an acceptable thesis.

51. COOPERATIVE BUSINESS. Stress is placed on the organizational, legal, and financial problems of farmers' business corporations which are engaged in buying and selling. Selected problems of general agricultural marketing are integrated with the course content. Mr. Henry. 3 lec.; 3 cr.

54. AGRICULTURAL FINANCE. The capital needs of different kinds of farms and farmer organizations. Saving, credit, renting, partnerships, and other means of obtaining capital. Organization, practices, and problems of credit institutions serving agriculture. The valuation and appraisal of farm property. *Prereq.*: Agricultural Economics 14 or concurrently. 2 lec.; 2 cr. (Alternate years; not offered in 1960-61.)

55. AGRICULTURAL MARKETING. The market structure for the distribution of agricultural products will be reviewed. Attention will be given to consumer demand, prices, and the efficiency of firms handling farm products. Each student is encouraged to study in detail a product of his particular interest. Mr. Bowring. 3 lec., 3 cr. (Alternate years; not offered 1960-61.)

61. AGRICULTURAL POLICY. The study of problems which are the basis for government and private policies in the production and marketing of agricultural products. Prices, production controls, marketing agreements, conservation, and farm credit are appraised relative to the objectives of agriculture and the concept of general welfare. *Prereq.*: 6 hours of Economics or Agricultural Economics. Mr. Drew. 3 lec.; 3 cr.

67-68. SPECIAL PROBLEMS IN AGRICULTURAL ECONOMICS. Special assignments in readings and problems to satisfy students' needs. Mr. Henry, Mr. Bowring, Mr. Drew. 1-3 cr.

72. RESEARCH METHODOLOGY. Designed to teach the scientific method of research to advanced students. Emphasis will be placed on the meaning of logic and the scientific method and on the application of research techniques to identifying and solving problems of agriculture. *Prereq.*: 6 hours of Economics or Agricultural Economics, 3 hours of statistics. Mr. Drew. 3 lec.; 3 cr.

101-102. ADVANCED FARM MANAGEMENT. Problems, theory, and procedure of organizing and operating farms for maximum profit and resource efficiency. 3 cr.

107. ADVANCED STATISTICS FOR AGRICULTURE. Use of statistical tools in measurement and analysis of data. Assigned problems and conferences. Mr. Bowring. 3 cr.

108. ADVANCED AGRICULTURAL ECONOMICS. Appraisal and application of relevant economic theory to problems in food production, marketing, and consumption. Mr. Henry. 3 cr.

181-182. READING AND RESEARCH IN AGRICULTURAL ECONOMICS. With the advice and consent of the instructor, a student, prepared by training and experience to do independent work, may register for a reading and research course. The student will undertake assigned problems and readings under guidance of the instructor. Mr. Henry, Mr. Bowring, Mr. Drew. 1-3 cr.

THESIS. To be arranged. 6-10 cr.

AGRICULTURAL EDUCATION

PHILIP S. BARTON, *Program Chairman*

Students majoring in Agricultural Education are expected to have had sufficient undergraduate work in this field to fulfill the requirements for state certification as a teacher of Vocational Agriculture or to be desirous of meeting such qualifications through graduate study.

The program is offered during the Summer Session only. The sequence of courses will cover a period of four summers and will then be repeated.

A comprehensive examination will be required of all candidates for the degree.

101. **ADVANCED METHODS IN FARM MECHANICS INSTRUCTION.** A study of the farm mechanics' problem and how to approach it in the high school. Consideration will be given from the standpoint of its place as a part of the course of study in Vocational Agriculture. The physical setup, as well as the processing of supplies and equipment, methods of supervision and direction of farm mechanics projects, and the preparation and presentation of demonstrations will be included. Mr. Gilman. 2 cr. (Offered in 1961.)

102. **METHODS IN TEACHING THE OPERATION AND MAINTENANCE OF FARM TRACTORS.** Methods in teaching the servicing and maintenance of the various mechanical systems found on farm tractors. Teaching plans, techniques of instruction, and essential skills will be considered. Demonstrations, discussions, and laboratory participation will make up a considerable part of the class work. Mr. Gilman. 2 cr. (Offered in 1963.)

103. **METHODS IN TEACHING THE CARE AND MAINTENANCE OF FARM MACHINERY.** Course content includes: Methods in teaching the care and maintenance of farm machinery, teaching plans, techniques of instruction, and the essential skills. Demonstrations, discussions, and laboratory participation will make up the balance of the work in this course. Mr. Gilman. 2 cr. (Offered in 1960.)

104. **PROGRAM PLANNING IN VOCATIONAL AGRICULTURE.** The gathering of basic community data; its interpretation and evaluation will be considered. The data obtained will serve as the basis for the preparation of the long-time plan, annual plan, and course of study for the local Department of Vocational Agriculture. Mr. Barton. 2 cr. (Offered in 1961.)

105. **SUPERVISED FARMING IN VOCATIONAL AGRICULTURE.** The course will cover developing of cooperative relations, selecting and developing individual programs with the students, and the supervision and evaluation of such programs. Mr. Barton. 2 cr. (Offered in 1962.)

106. **PREPARATION AND USE OF VISUAL AIDS FOR TEACHING VOCATIONAL AGRICULTURE.** The purpose of visual aids and the kinds best adapted to use in the program, together with their preparation and use, will be given primary consideration in this course. 2 cr. (Offered in 1962.)

107. **ORGANIZATION AND SUPERVISION OF THE FUTURE FARMERS OF AMERICA PROGRAM.** The purposes and organization of the Future Farmers of America, establishing the local chapter, planning and developing a program of work, ways and means of improving the local chapter, together with methods of evaluation will be covered. 2 cr. (Offered in 1962.)

108. **ORGANIZING, TEACHING, AND SUPERVISING YOUNG AND ADULT FARMER PROGRAMS.** The techniques of organization, course planning, methods of teaching, and the supervision of farming programs as they apply to instruction with out-of-school groups will be given consideration. Mr. Barton. 2 cr. (Offered in 1963.)

109. **COMMUNITY ORGANIZATION AND PUBLIC RELATIONS.** A study of the composition, purposes, and objectives of the various social and economic organizations operating in local communities; importance of their membership to the general welfare of the area and the development of a public relations program for a teacher of agriculture to promote the program of Vocational Agriculture on the local, state, and national level. 2 c. (Offered in 1960.)

110. **PHILOSOPHY OF VOCATIONAL EDUCATION.** A study of the development of Vocational Education in the United States with emphasis on the socio-economic influences responsible for its establishment. Its relationship with general education, together with the coordination of instructional programs in the various vocational fields. 2 cr. (Offered in 1960.)

111, 112, 113. **RESEARCH IN AGRICULTURAL EDUCATION.** Individual study problems in various phases of Agricultural Education. *Prereq.:* Permission of staff. 2 cr.

AGRONOMY

ALLAN B. PRINCE, *Chairman*

Before students are admitted to graduate study in Agronomy they must have had basic courses in soils and crops as well as adequate preparation in the biological and physical sciences. A candidate for the Master's degree shall pass an oral or written examination covering his graduate courses and thesis.

51. **PASTURE-HAYLAND AND TURF MANAGEMENT.** The choice of species, and the preparation and maintenance of stands and swards through adequate management and fertilization. Consideration also will be given to lawns and turf areas. Current research literature, individual problems, and field trips will be utilized. Mr. Higgins. *Prereq.:* Agronomy 28 and a minimum of 6 other credits in Agronomy, or permission of the instructor. 2 lec.; 1 lab.; 3 cr.

52. **A REVIEW OF AGRONOMY.** Principles and practices in agronomic crop production, including the management of soils and the use and response of lime and fertilizers. For teachers of Vocational Agriculture and other students with the permission of their advisors. Staff. Summer Session only; offered in 1961. Two hours daily lec. and lab.; 2 cr.

57. **PHYSICS AND CHEMISTRY OF SOIL.** Physical and chemical properties of soils; their measurement and relation to structure; water movement; temperature; and liberation, absorption, and fixation of elements in soils. Mr. Prince. *Prereq.:* Permission of the instructor. 3 lec.; 2 lab.; 5 cr. (Alternate years; offered 1960-61.)

58. **SOIL CLASSIFICATION AND MAPPING.** The genesis, morphology, classification, and mapping of soils. Mr. Peterson. *Prereq.:* Agronomy 1, 11, and Geology 7. 2 lec.; 1 lab.; 3 cr. (Alternate years; not offered in 1960-61.)

60. **SOIL AND WATER CONSERVATION.** Management of soil and water in accordance with the needs and capabilities of the land. Mr. Peterson. *Prereq.:* Agronomy 1, 11, and 14. 2 lec.; 1 lab.; 3 cr. (Alternate years; offered in 1960-61.)

62. BREEDING OF FIELD CROPS. Methods for developing and evaluating improved varieties of grasses, legumes, and cereal crops. Major emphasis will be given to corn breeding. Laboratory will consist of practical work in selfing and crossing, in inheritance studies, and statistical analysis of experimental plot designs. Mr. Dunn. 2 lec.; 1 lab.; 3 cr. (Alternate years; not offered 1960-61.)

71, 72. AGRONOMY SEMINAR. Library and reference work on special phases of soil and crop problems. Practice in consulting literature and in preparation and presentation of reports and abstracts. Staff. *Prereq.*: Agronomy 1, 11, and 14. 1 cr. Required each semester of seniors and graduate students majoring in agronomy; elective for other qualified students.

75, 76. INVESTIGATIONS IN

- a. Crop Production — Mr. Higgins
- b. Plant Breeding — Mr. Dunn
- c. Physics and Chemistry of Soils — Mr. Prince
- d. Soil Fertility — Mr. Peterson

Elective only after consultation with the instructor in charge. Hours to be arranged. 1-4 credits.

104. ADVANCED SOIL CHEMISTRY. Lectures, discussions, and problem work in laboratory. Physical chemistry of soils and soil colloidal phenomena. Anion and cation exchange mechanisms in soils. Theories of swelling. Crystallographic properties of the clay colloids and their relation to cation and anion exchange. The nature of soil acidity. Oxidation-reduction phenomena in soils. Mr. Prince. *Prereq.*: Agronomy 57, and Chemistry 17. (At least one semester of physical chemistry recommended.) 3 cr.

105, 106. RESEARCH TECHNIQUES.

- a. Crop Production — Mr. Higgins
- b. Plant Breeding — Mr. Dunn
- c. Soil Fertility — Mr. Peterson

Elective only after consultation with the instructor in charge. Hours to be arranged. 1-4 credits.

THESIS. A thesis study of some phase of Soil Science or Plant Science is required of all candidates for an advanced degree. 6 to 10 cr.

ANIMAL SCIENCE

LORING V. TIRRELL, *Chairman of Animal Science*

Students admitted to graduate study in Animal Science are expected to have had satisfactory undergraduate training in Animal Science, Dairy Science, or other biological sciences. Candidates majoring in Animal Science will be required to pass an oral examination and prepare a thesis.

51. ANIMAL BREEDING. The principles and practices of breeding farm animals, including cross-breeding, in-breeding, selection, inheritance, breed analysis, reproductive efficiency, fertility, sterility, Mendelism in relation to

farm animals, acquired characteristics and variation. Practice is given in tracing and studying pedigrees. Mr. Smith. 2 lec.; 1 lab.; 3 cr.

52. ANIMAL SCIENCE SEMINAR. Library and reference work and the preparation of papers on various Animal Science subjects. Mr. Tirrell. *Prereq.*: Animal Breeding. Hours and credits to be arranged.

105. PROBLEMS IN ANIMAL BREEDING. Studies in practical breeding problems with beef and dual-purpose cattle, sheep, horses, and hogs. The genetic principles important to successful livestock production will be emphasized. Mr. Tirrell and Mr. Smith. *Prereq.*: A major in Animal Science, Dairy Science, or equivalent. 2 lec.; 1 lab.; 3 cr.

106. MEATS, LIVESTOCK MARKETS, AND PRODUCTS. The essential factors in meat selection, cutting, curing, and smoking; study and discussion relative to the problems of livestock marketing and the procedure in the large central markets. Trips are taken to various packing plants. Mr. Smith. *Prereq.*: A major in Animal Science or equivalent. 2 lec.; 1 lab.; 3 cr.

BACTERIOLOGY

LAWRENCE W. SLANETZ, *Chairman*

Students admitted to graduate study in Bacteriology are expected to have had preparation in the biological and physical sciences and in the basic courses in Bacteriology. A thesis is required and a candidate for the Master's degree shall pass an oral examination covering his graduate courses and thesis.

53. IMMUNOLOGY AND SEROLOGY. The theories of infection and immunity; production of vaccines; toxins, and antisera; serological techniques for disease diagnosis and identification of bacteria, including agglutination, precipitin, and complement fixation tests. Mr. Metcalf. *Prereq.*: Pathogenic Bacteriology. 2 lec.; 2 lab.; 4 cr.

54. INDUSTRIAL MICROBIOLOGY. Consideration of the role of microorganisms important in industrial processes. Isolation and study of the bacteria, yeasts, and molds used for the manufacture of industrial products. Discussion of the theoretical aspects for fermentation and respiration and their practical applications. Typical industrial processes employing microorganisms and chemical isolation of products will be carried out in the laboratory. Mr. Chesbro. *Prereq.*: Bact. 1 and Organic Chemistry. 2 lec.; 2 lab.; 4 cr. (Alternate years; offered in 1960-61.)

55, 56. PROBLEMS IN BACTERIOLOGY. Special problems, depending upon the training and desire of the student. Elective only upon consultation. Mr. Slanetz and staff. Credits to be arranged.

60. VIROLOGY. An introduction to the animal and plant viruses, including bacteriophages and the rickettsiae. A consideration of techniques, pathogenesis, immunity, and host-virus relationships. Mr. Metcalf. *Prereq.*: Pathogenic Bacteriology. 1 lec.; 3 lab.; 4 cr.

101. PHYSIOLOGY OF BACTERIA. A study of the growth, nutrition, and metabolism of bacteria; influence of physical and chemical environment on

growth; bacterial enzymes, protein decomposition and fermentation. Mr. Chesbro. *Prereq.*: Biological Chemistry (may be taken concurrently) and one year of Bacteriology. 2 lec.; 2 lab.; 4 cr.

104. **SYSTEMATIC BACTERIOLOGY.** A study of procedures and methods for the classification of bacteria; review of modern systems of classification. Mr. Slanetz. *Prereq.*: One year of Bacteriology. 2 lec.; 1 lab.; 3 cr.

108. **PATHOGENIC AND DIAGNOSTIC BACTERIOLOGY.** A study of the morphological, cultural, biochemical, serological, and pathogenic characteristics of microorganisms causing human and animal diseases. Students will be expected to perform the laboratory procedures for the diagnosis of various infectious diseases. Mr. Metcalf. *Prereq.*: General Bacteriology. 2 lec.; 2 lab.; 4 cr.

109, 110. **BACTERIOLOGY SEMINAR.** Reports and discussions on bacteriological literature and recent developments in bacteriology. Mr. Slanetz and staff. *Prereq.*: Permission of the instructor. 1 rec.; 1 cr.

153. **ADVANCED IMMUNOLOGY AND SEROLOGY.** The theories of infection and immunity; production of vaccines; toxins, and antisera; serological techniques for disease diagnosis and identification of bacteria, including agglutination, precipitin, and complement fixation tests. Students will be assigned special problems on certain phases of the lecture or laboratory work. Mr. Metcalf. *Prereq.*: Pathogenic Bacteriology. 2 lec.; 2 lab.; 4 cr.

THESIS. 6-10 cr.

BIOCHEMISTRY

ARTHUR E. TEERI, *Chairman*

Students admitted to graduate study in Biochemistry are expected to have had preparation in the biological sciences, in mathematics, in physics, and in general analytical, and organic chemistry. The candidate for the M.S. degree will be required to prepare a thesis, and to pass an oral examination covering his graduate courses and thesis.

51-52. **GENERAL BIOCHEMISTRY.** The chemistry of fats, carbohydrates, and proteins; colloids, enzyme action, digestion, metabolism, and excretion. Mr. Shimer, Mr. Teeri. *Prereq.*: Satisfactory preparation in organic chemistry and quantitative analysis. 3 lec.; 2 labs.; 5 cr.*

56. **PHYSIOLOGICAL CHEMISTRY.** The qualitative and quantitative methods fundamental to medical diagnostic work. The chemistry of fats, carbohydrates, and proteins; enzymes, digestion, metabolism, and excretion. Mr. Teeri. *Prereq.*: Satisfactory preparation in organic chemistry and quantitative analysis. 3 lec.; 2 lab.; 5 cr.

* Under special conditions a graduate student may register for the lectures in this course (3 credits) after obtaining the consent of the instructor and the approval of the student's adviser.

101, 102. **ADVANCED BIOCHEMISTRY.** An advanced study of the fundamental principles of biochemistry. Mr. Teeri, Mr. Routley. 2 lec.; 2 cr.

103, 104. **SPECIAL PROBLEMS.** Mr. Teeri, Mr. Shimer, Mr. Routley, Miss Loughlin. *Prereq.:* Satisfactory preparation in analytical, organic, and biological chemistry. Subject matter and credits to be arranged.

105, 106. **BIOCHEMISTRY SEMINAR.** Reports and discussions of biochemical literature and recent developments in biochemistry. *Prereq.:* Permission of the Department Chairman. 1 cr.

107, 108. **ADVANCED BIOCHEMISTRY LABORATORY.** An advanced laboratory course with special emphasis on the methods used in biochemical research. Mr. Teeri and staff. *Prereq.:* Permission of the Department Chairman. 1 lec.; 2 lab.; 3 cr.

THESIS. To be arranged. 6-10 cr.

BIOLOGY

GEORGE M. MOORE, *Chairman of Committee*

Students admitted to graduate study in Biology must have completed an undergraduate major in Biology or in some field of the biological sciences. Suitable training in the physical sciences is also necessary. Students who lack undergraduate training in any of the fields of the biological sciences may be required to complete certain courses in these fields which do not carry graduate credit before they are admitted to candidacy for a degree.

Graduate work in Biology is under the direction of a committee consisting of the Chairmen of the Departments of Bacteriology, Botany, Entomology, and Zoology. This committee shall determine, in light of the student's objectives, the courses and requirements to be met by the candidate. Candidates for the Master's Degree in Biology shall pass an oral examination covering their general preparation in the field, and the thesis.

THESIS REQUIREMENTS. A thesis may be required of a student who secures the Master's degree in Biology. The number of thesis credits will be *six*. In certain cases, where it seems appropriate in the light of the student's educational objectives, the thesis requirement may be waived. Permission to waive the thesis requirement will be granted on recommendation of the committee mentioned above. When permission is granted to waive the thesis requirement, the student shall present two graduate credits in Seminar (Bact. 57, 58; Bot. 59, 60; or Zool. 87, 88).

71, 72. **PRINCIPLES OF ECOLOGY.** The study of the interrelationships of plants and animals with both their living and non-living environments. Attention will be given to the dynamic interplay of forces in terrestrial, freshwater,

and marine habitats. Consideration will be given to energy relationships, limiting factors, community organization, succession, and biogeography. Laboratory work will be selected to aid development of useful techniques, such as censusing, mapping, statistics, and environmental measurements. Mr. Swan, Mr. Reed, Mr. Sawyer. *Prereq.*: Bot. 6, 56, and one of the following: Zool. 55, 56, or 77. 2 rec.; 2 lab.; 4 cr.

91. **BIOLOGY-EDUCATION. PROBLEMS IN THE TEACHING OF HIGH-SCHOOL BIOLOGY.** Objectives and methods of teaching; the selection and organization of materials; the preparation of visual aids; the setting up of aquaria and other projects. Some instruction in the preparation of biological materials for the classroom; instruction in making models and aquaria. The use of the field trip as a tool in teaching high-school biology. Mr. Schaefer. *Prereq.*: Two years of biological sciences and Principles and Problems of Teaching in the Secondary School. 2 rec.; 1 lab. or field trip; 3 cr.

171, 172. **PRINCIPLES OF ECOLOGY.** The study of the interrelationships of plants and animals with both their living and non-living environments. Attention will be given to the dynamic interplay of forces in terrestrial, freshwater, and marine habitats. Consideration will be given to energy relationships, limiting factors, community organization, succession, and biogeography. Laboratory work will be selected to aid development of useful techniques, such as censusing, mapping, statistics, and environmental measurements. This course will meet with Biology 71-72. Students are expected to do extra reading and laboratory work. Not open to students who have credit for Biology 71-72. Mr. Swan, Mr. Reed, Mr. Sawyer. *Prereq.*: Bot. 6, 56, and one of the following: Zool. 55, 56, or 77. 2 rec.; 2 lab.; 4 cr.

For listings of other courses see: Bacteriology, Botany, Entomology, and Zoology.

BOTANY

ALBION R. HODGDON, *Chairman*

Students admitted to graduate study in Botany are expected to have had adequate preparation in basic Botany courses and in the physical sciences. The candidate for the M.S. degree will be required to pass an oral examination and to prepare a thesis. Thesis credits may be from 6 to 10 depending on the research problem involved. Students who are working toward the Ph.D. degree must demonstrate a reading knowledge of two foreign languages, preferably French and German, and must complete a thesis-dissertation on some original research in Botany. The subject-matter fields for graduate study in Botany are: Systematic Botany, Mr. Hodgdon; Plant Ecology, Mr. Reed; Plant Physiology, Mr. Dunn; Plant Morphology and Anatomy, Miss Nast; Plant Pathology, Mr. Rich, and Mr. Kilpatrick; Mycology, Mr. Richards; Cytology, Mr. Schreiber.

51. **PLANT PATHOLOGY.** The nature of disease in plants, the etiology, symptomatology, and classification of plant diseases. Mr. Rich. *Prereq.:* Bot. 1 and 3. 1 lec.; 2 lab.; 3 cr.

52. **PRINCIPLES OF PLANT-DISEASE CONTROL.** Exclusion, eradication, protection, and immunization, and the specific, practical methods used to control plant diseases. Mr. Rich. *Prereq.:* Botany 51. 1 lec.; 2 lab.; 3 cr. (Alternate years; not offered in 1960-61.)

53. **PLANT ANATOMY.** The anatomy of vascular plants with special emphasis upon tissue development and structure. Miss Nast. *Prereq.:* Bot. 1 or Bot. 3. 1 lec.; 2 lab.; 3 cr.

54. **CYTOLOGY.** The structure, physiological behavior, and development of cells. The cellular basis of heredity. Mr. Schreiber. 2 lec.; 1 lab.; 3 cr.

55. **ADVANCED SYSTEMATIC BOTANY.** The principles and laws of plant classification and nomenclature; study of plant families, field, and herbarium work. Mr. Hodgdon. *Prereq.:* Botany 6. Hours to be arranged. 4 cr.

56. **PLANT PHYSIOLOGY.** Structure and properties of cells, tissues, and organs; absorption and movement of water; metabolism; growth and irritability. Mr. Dunn. *Prereq.:* Bot. 1 or Bot. 3, and one year of Chemistry. 2 lec.; 2 lab.; 4 cr.

57, 58. **INVESTIGATIONS IN (a) SYSTEMATIC BOTANY, (b) PLANT PHYSIOLOGY, (c) PLANT PATHOLOGY, (d) PLANT ANATOMY AND MORPHOLOGY, (e) PLANT ECOLOGY, (f) AQUATIC PLANTS, AND (g) CYTOLOGY.** Elective only upon consultation with the Chairman of Department. Mr. Hodgdon, Mr. Dunn, Mr. Rich, Miss Nast, Mr. Reed, Mr. Schreiber. Hours to be arranged. 2 to 6 credits.

59, 60. **BOTANY SEMINAR.** Library reference work and the preparation of papers and abstracts on special phases of botany. Practice in the preparation of oral and written reports. Botany staff. *Prereq.:* 6 hours of botany, or permission of the Chairman of the Department. This course may be repeated for credit. 1 rec.; 1 cr.

62. **MORPHOLOGY OF THE VASCULAR PLANTS.** Life histories and evolution of the pteridophytes, gymnosperms and angiosperms, including comparisons of general structure and sexual organs. Miss Nast. *Prereq.:* Bot. 1 or Bot. 3. 2 lec.; 2 lab.; 4 cr. (Alternate years; offered 1960-61.)

101. **PLANT GEOGRAPHY.** The distribution of plants, a consideration of vegetation types and floras and problems of endemism with emphasis on North America; the major influential factors such as geologic, climatic, edaphic and biotic including man's activities. The major contributions from Humboldt to the present time. Mr. Hodgdon. 3 cr. (Alternate years; offered in 1960-61.)

103. **ADVANCED PLANT PATHOLOGY.** Advanced theories and methods in plant pathology. Mr. Rich. *Prereq.:* Botany 51. Assigned reading, conferences and laboratory. 2 cr. (Alternate years; not offered in 1960-61.)

104. **MICROTECHNIQUE.** A methods course in embedding, sectioning, and staining plant tissues, and introduction to photomicrography. Miss Nast. *Prereq.:* Botany 1 or Botany 3. 3 cr. (Alternate years; not offered in 1960-61.)

105. **ADVANCED PLANT PHYSIOLOGY.** An intensive study of plant physiological phenomena, such as absorption, permeability, mineral nutrition, photosynthesis and light effects, respiration, growth regulator effects. Mr. Dunn. *Prereq.:* Botany 56 or equivalent, or adequate preparation in the physical sciences. Conferences, laboratory, and assigned reading. 4 cr. (Alternate years; not offered in 1960-61.)

107, 108. **INVESTIGATION IN (a) SYSTEMATIC BOTANY, (b) PLANT PHYSIOLOGY, (c) PLANT PATHOLOGY, (d) PLANT ANATOMY AND MORPHOLOGY, (e) PLANT ECOLOGY, (f) MYCOLOGY, AND (g) CYTOLOGY.** Elective only upon consultation with the Chairman of the Department. Mr. Hodgdon, Mr. Dunn, Mr. Rich, Miss Nast, Mr. Reed, Mr. Richards, Mr. Schreiber. Hours to be arranged. 2 to 6 credits.

112. **MYCOLOGY.** Studies of the parasitic and saprophytic fungi, their growth, reproduction, and identification. Mr. Richards. Laboratory and assigned reading. 1 lec.; 2 lab.; 3 cr.

M. S. THESIS. 6-10 cr.

DOCTORAL DISSERTATION.

CHEMICAL ENGINEERING

OSWALD T. ZIMMERMAN, *Chairman*

To be admitted to graduate study in Chemical Engineering an applicant shall be expected to have completed a course of study substantially equivalent to that required for the degree of Bachelor of Science in Chemical Engineering in this University. However, students with good undergraduate records but with deficiencies in certain areas may be admitted on condition that they complete specified courses without credit to make up for their deficiencies.

A candidate for the Master's degree in Chemical Engineering must complete a thesis, for which up to 6 credits will be allowed, and he must pass an oral examination covering his thesis and graduate courses.

51. **CHEMICAL ENGINEERING PRINCIPLES I.** Units and dimensional analysis; material and energy balances; gaseous, solid, and liquid fuels; combustion; introduction to fluid flow and heat transfer. Laboratory work includes experiments in the use of various types of temperature measuring devices and flow meters; gas analysis; calorimetry; and heat transfer. Mr. Lavine, 3 lec. or rec.; 1 lab.; 4 cr.

52. **CHEMICAL ENGINEERING PRINCIPLES II.** A number of selected processes from the points of view of thermodynamics, kinetics, catalysis, instrumentation, materials handling, and materials of construction; and an introduction to costs. Processes studied include petroleum refining, ammonia synthesis, chlorine-caustic production, and the manufacture of sulfuric, nitric, and hydrochloric acids, and soda ash. Laboratory work includes experiments in the use of various types of apparatus for measuring the viscosity and other

properties of petroleum products; measurements of the rates of chemical reactions; and experiments in size reduction and separation, and fluidization. Mr. Lavine. 3 lec. or rec.; 1 lab.; 4 cr.

54. **CHEMICAL ENGINEERING PRINCIPLES III.** The theories and applications of fluid mechanics, heat transfer, evaporation, crystallization, filtration, humidity and air conditioning, and drying. Mr. Zimmerman. 3 lec. or rec.; 3 cr.

61. **METALLOGRAPHY.** The composition and properties of metals and alloys, based principally on the electron theory of solids. Among the subjects covered are crystallography, including X-ray crystallography, and the effects of mechanical and thermal treatment on the properties of metals and alloys, the preparation and microscopic examination of polished sections, and X-ray diffraction measurements. Mr. Schneer and Mr. Bostian. 2 lec. or rec.; 1 lab.; 3 cr.

63. **CHEMICAL ENGINEERING PRINCIPLES IV.** The theories and applications of the chemical engineering diffusional operations. Subject matter covered includes mass transfer, simultaneous mass and heat transfer, gas and liquid diffusion, gas absorption, distillation, liquid-liquid extraction, and solid-liquid extraction. Mr. Zimmerman. 3 lec. or rec.; 3 cr. (Not offered 1960-1961.)

65. **CHEMICAL ENGINEERING LABORATORY.** A laboratory study, using typical chemical engineering equipment, of fluid flow, heat transfer, evaporation, distillation, humidification, drying, filtration, gas absorption, liquid-liquid extraction, and solid-liquid extraction. Mr. Lavine. 2 lab.; 2 cr. (Not offered 1960-1961.)

66. **CHEMICAL ENGINEERING ECONOMICS AND PLANT DESIGN.** The principles of cost engineering, including estimation of plant investment, working capital, operating costs, labor requirements, payout time, and profitability. Subject matter covered includes value of money, capitalized costs, simple and compound interest, depreciation, taxes and insurance, labor requirements, overhead, financing of chemical enterprises, design of equipment and plants for minimum cost, plant location, transportation, sales cost, equipment cost, and cost indexes. Each class selects one or more problems involving the complete design of a chemical plant. For each problem, the most desirable process must be determined, the site selected, the equipment and plant designed, calculations made for all costs, profitability and payout time, and a complete report prepared, including the drawings of equipment and plant layout. Mr. Lavine. 1 lec. or rec.; 3 lab.; 4 cr. (Not offered 1960-61.)

69. **CHEMICAL ENGINEERING PROJECT.** Each student selects a research problem which he carries out independently under faculty supervision. Intensive study in both the library and the laboratory and a satisfactory report upon completion of the work are required. Mr. Zimmerman. 3 lab.; 3 cr. (Not offered 1960-1961.)

74-75. **UNIT OPERATIONS.** The theory and practice of the fundamental chemical engineering unit operations, including flow of fluids, flow of heat, evaporation, distillation, drying, filtration, gas absorption, extraction, humidification and air conditioning, crystallization, crushing and grinding, and size separation. Mr. Bostian. 3 lec.; 3 cr.

76. **CHEMICAL ENGINEERING ECONOMICS.** The economic factors involved in industrial chemical processes and the application of economic balances to the design and selection of chemical engineering equipment. Mr. Zimmerman. 3 lec.; 3 cr.

77. UNIT OPERATIONS LABORATORY. Experiments based upon the unit operations are performed on typical chemical engineering equipment. Mr. Bostian. 3 lab.; 3 cr.

78. CHEMICAL PLANT DESIGN. The design and layout of chemical plants and equipment. The assigned problems are of a practical nature, such as the manufacture of some chemical product, and their solution will include the design or selection of all equipment and drawings of equipment, plant, and layout. Mr. Lavine. 3 lab.; 3 cr.

79. CHEMICAL ENGINEERING THERMODYNAMICS. A study of the fundamental laws of energy and their application to chemical engineering problems. Mr. Zimmerman. 3 lec.; 3 cr.

80. CHEMICAL ENGINEERING PROJECT. In this course each student selects a research problem which he carries out independently under faculty supervision. Intense study in both the library and the laboratory and a satisfactory thesis at the completion of the work are required. Mr. Zimmerman or Mr. Lavine. 5 lab.; 5 cr.

135. UNIT OPERATIONS — FLUID FLOW, HEAT FLOW, AND EVAPORATION. An advanced course dealing with the fundamental theory and applications of these operations. Mr. Zimmerman. 2 lec. or rec.; 2 cr.

136. UNIT OPERATIONS — DIFFUSION OPERATIONS. An advanced study of the principles of diffusion and their application to the unit operations of distillation, absorption, drying, humidification, and extraction. Mr. Zimmerman. 2 lec. or rec.; 2 cr.

137, 138. UNIT PROCESSES. A study of the more recent developments in pyrolysis, oxidation, chlorination, nitration, polymerization, and other unit processes. Mr. Lavine. 2 lec.; 2 cr.

139. CHEMICAL ENGINEERING THERMODYNAMICS. A study of recent developments in thermodynamics with particular emphasis on low-temperature and high-pressure processes. Mr. Zimmerman. 2 lec.; 1 rec.; 3 cr.

141, 142. THESIS — PROBLEMS IN CHEMICAL ENGINEERING. Independent investigations in some phase of chemical engineering. Mr. Zimmerman. Credits to be arranged.

151. INTRODUCTION TO NUCLEAR ENGINEERING. The scientific and engineering development of nuclear reactors is treated, including basic binding energy physics, nuclear stability, radioactivity, the elements of nuclear reactor theory, and the engineering problems of heat transfer, fluid flow, materials selection, and shielding. This course is intended for any interested graduate students. Mr. Bostian. 3 lec.; 3 cr.

152. NUCLEAR CHEMICAL TECHNOLOGY. The design, construction, and operation of nuclear process equipment, including reactors and associated chemical processing facilities, and isotope separations plants. The technology of applied radiation chemistry is also treated. Intended primarily for graduate students in Chemical Engineering. Mr. Bostian. 3 lec.; 3 cr.

CHEMISTRY

HAROLD A. IDDLES, *Chairman*

Admission to graduate study for the M.S. and Ph.D. degrees in Chemistry is based upon the general cumulative undergraduate average of 2.5 and requires the usual undergraduate courses in general chemistry, analytical chemistry, organic chemistry, and physical chemistry with the supporting courses in mathematics and physics.

Entering graduate students are expected to take proficiency tests in the fields of general inorganic, organic, and physical chemistry to assist the adviser in starting the new student's graduate work at the proper level. These examinations will be offered at the beginning of the fall semester in September. Normally the residence requirements will consist of one academic year for the M.S. degree and a total of three academic years for the Ph.D. degree. Both degrees require the completion of a research problem which is described in a written thesis. The final examination for both M.S. and Ph.D. degrees is an oral defense of the thesis.

The Ph.D. candidate will be expected to demonstrate proficiency in reading chemical literature in German and French or Russian. He will also demonstrate to the Doctoral Committee that he has a broad basic knowledge of the field of chemistry 1) by taking certain fundamental graduate courses and 2) by means of a series of examinations in his major field. The principal emphasis of the last two years will be on a research project which will constitute the dissertation. During this time the doctoral candidate will present and defend two original research proposals before his Doctoral Committee.

Inorganic Chemistry

85. INORGANIC CHEMISTRY. The relationship between chemical reactions and modern concepts of inorganic chemistry on a moderate level. The applicability and limitations of the newer ideas. Mr. Haendler. *Prereq.*: Chem. 83-84, or permission. 3 lec.; 3 cr.

104. ADVANCED INORGANIC CHEMISTRY. A survey of inorganic chemistry from the modern point of view, with emphasis on theoretical and structural concepts. Mr. Haendler. *Prereq.*: Chem. 85, or its equivalent. 3 lec.; 3 cr.

107. ADVANCED INORGANIC CHEMISTRY. The chemistry of coordination compounds, their structure, stereochemistry, and reactions. The metal-ligand bond. Mr. Haendler. *Prereq.*: Chem. 104. 3 lec.; 3 cr.

132a. ADVANCED INORGANIC CHEMISTRY. A course on the theory and practice of x-ray diffraction and the determination of crystal structure. Mr. Haendler. *Prereq.*: Chem. 103. 3 lec.; 3 cr.

Analytical Chemistry

61-62. ANALYTICAL CHEMISTRY. The theory and laboratory technique necessary for quantitative analysis. A thorough background of the fundamental procedures is followed by the use of the newer procedures and instrumental techniques. The lecture work stresses problem solution. Instruments used include the spectrograph, spectrophotometer, polarograph, electrometric titrimeters, colorimeters. Mr. Amell and Mr. Daggett. *Prereq.*: Chem. 5, 6. 3 lec.; 2 lab.; 5 cr.

63. INTRODUCTORY RADIOCHEMICAL TECHNIQUES. A discussion of radiochemical techniques and laboratory practice in the use of apparatus in many fields of science which utilizes radiochemical operations. *Prereq.*: General Inorganic Chemistry and General Physics. Mr. Amell. 3 lec.; 2 lab.; 5 cr.

130. ADVANCED ANALYTICAL CHEMISTRY. This course will consider first a comprehensive review of the basic principles of qualitative and quantitative analysis, including stoichiometric calculations. More advanced methods will then be considered from the standpoints of basic principles and applications. Included will be such subjects as polarography, potentiometric titrations, titrations in nonaqueous solvents, chromatography, thermogravimetric analysis, applications to radioactive tracers, spectrophotometry, mass spectrometry, etc. Mr. Daggett. 3 lec.; 3 cr.

Organic Chemistry

55-56. STRUCTURAL AND THEORETICAL PROBLEMS OF MODERN ORGANIC CHEMISTRY. An intensive study of the methods of preparation and reactions of the principal classes of organic compounds. The electron theory of organic chemistry is used to correlate these reactions. The variation in reactivity of these various classes of organic compounds is utilized as a method of characterization of organic compounds. Emphasis is on the solution of assigned problems. Mr. Lyle. *Prereq.*: One year of organic chemistry. 3 lec. First semester; 1 lec. and 2 labs. Second semester; 3 cr.

101-102. ADVANCED ORGANIC CHEMISTRY. A study of the reactions of the more important functional groups. Current electronic and structural theories are used in correlating facts wherever possible. Mr. Kuivila. *Prereq.*: A year's course in organic chemistry. 3 lec.; 3 cr.

111. ORGANIC CHEMISTRY. The chemistry of the polynuclear compounds and heterocyclic systems. Mr. Lyle. 3 lec.; 3 cr.

112. ORGANIC CHEMISTRY. The study of the degradation and synthesis of representative alkaloids and steroids. Mr. Lyle. 3 lec.; 3 cr.

115. MODERN LABORATORY TECHNIQUES IN ORGANIC CHEMISTRY. A course to acquaint the graduate student with the principles and practice of the more recent laboratory methods. Techniques such as fractional distillation, chromatography, catalytic hydrogenation, and ultraviolet and infrared spectroscopy are discussed and employed. Mr. Jones. 2 lec.; 1 lab.; 3 cr.

116. ORGANIC QUALITATIVE ANALYSIS. The reactions and properties of organic compounds. Use of group reactions in the identification of organic substances. Mr. Lyle. 1 lec.; 2 to 4 lab.; 3 to 5 cr.

117. **STEREOCHEMISTRY.** A discussion of the structural theory of organic chemistry in its broader aspects. Besides optical and geometrical isomerism other topics such as steric hindrance, strain theory, and conformational analysis are considered. Mr. Kuivila. *Prereq.:* Structural and Theoretical Problems of Modern Organic Chemistry or equivalent. 3 lec.; 3 cr.

118. **REACTION MECHANISMS.** Study of the theoretical and experimental tools used in the study of organic reaction mechanisms and application of these to reactions such as the displacement reaction, eliminations, additions to the double bond, carbonyl and carboxyl reactions, and aromatic substitutions. Mr. Kuivila. *Prereq.:* Stereochemistry is recommended but not required. 3 lec.; 3 cr.

Physical Chemistry

83-84. **ELEMENTARY PHYSICAL CHEMISTRY.** The properties of gases, liquids, and solids; thermochemistry and thermodynamics; solutions, chemical equilibria, reaction rates, conductance and electromotive force. Mr. Wheeler. *Prereq.:* Quantitative Analysis, Calculus. Physics. 3 lec.; 2 lab.; 5 cr. (Cannot be taken for credit by graduate students in Chemistry.)

86. **ADVANCED PHYSICAL CHEMISTRY.** A review of selected topics in elementary physical chemistry. Mr. Amell. *Prereq.:* One year of Physical Chemistry. 3 lec.; 3 cr.

105-106. **ADVANCED PHYSICAL CHEMISTRY.** A detailed study of fundamental physico-chemical principles covering the three states of matter, change of state, physical properties and molecular structure, solutions, phase equilibria, chemical equilibrium, and free energy. Mr. Pilar. *Prereq.:* Undergraduate Physical Chemistry. 3 lec.; 3 cr.

121. **PHYSICAL CHEMISTRY — CHEMICAL KINETICS.** A study of the kinetics of homogeneous and heterogeneous reactions in gaseous and liquid systems, including an introduction to photochemistry. Mr. Amell. *Prereq.:* One year of Physical Chemistry. 3 lec.; 3 cr.

122. **PHYSICAL CHEMISTRY — CHEMICAL THERMODYNAMICS.** A study of the foundations and inter-relationships of the theory of thermodynamics. The methods by which the theoretical principles may be applied to practical problems are discussed and applied. Mr. Wheeler. *Prereq.:* Chem. 105. 3 lec.; 3 cr.

124. **ADVANCED PHYSICAL CHEMISTRY LABORATORY.** The more modern experimental technique of physical chemistry. Emphasis on the needs and interests of each individual student. Topics will include the measurement of refractive index, molecular rotation, activity coefficients by vapor pressure and E.M.F. methods, heterogeneous and homogeneous equilibrium constants, and kinetic constants. Mr. Wheeler. 1 lec.; 2 lab.; 3 cr.

126. **NUCLEAR AND RADIOCHEMISTRY.** A detailed study of nuclear structure and reactions, particle accelerators, radioactive decay, detection of particles, and the interaction of particles with matter. Application of radiochemistry to chemical systems and research. Mr. Amell. 3 lec.; 3 cr.

127-128. THEORETICAL CHEMISTRY. Atomic and molecular structure; principles of quantum mechanics; Schrodinger equation; free electron, molecular orbital and valence bond theories of chemical systems; statistical mechanics; distribution laws; application of statistical mechanics to chemical problems. Mr. Pilar. *Prereq.*: 105-106. 3 lec.; 3 cr.

131-132. COLLOQUIUM IN CHEMISTRY.

- a. Inorganic Chemistry, Mr. Haendler
- b. History of Chemistry, Mr. Funkhouser
- c. Organic Chemistry, Mr. Lyle
- d. Theoretical Organic Chemistry, Mr. Kuivila
- e. Organic Chemistry, Mr. Iddles
- f. Physical Chemistry, Mr. Amell
- g. Physical Chemistry, Mr. Pilar
- h. Physical Chemistry, Mr. Wheeler
- i. Analytical Chemistry, Mr. Daggett
- j. Organic Chemistry, Mr. Jones
- k. Organic Chemistry, Mrs. Lyle

3 lec.; 3 cr. Sections of the course may be taken to a total of 12 cr.

141-142. SEMINAR. Presentation and discussion of recent investigations in the field of chemistry. 1 cr.

151, 152. THESIS PROBLEMS IN CHEMISTRY. Conferences, library, and experimental work in some field of chemistry. Analytical Chemistry and Photochemistry, Mr. Daggett; Inorganic Chemistry, Mr. Haendler; Organic Chemistry, Mr. Iddles, Mr. Funkhouser, Mr. Kuivila, Mr. Lyle, Mr. Jones, and Mrs. Lyle; Physical Chemistry, Mr. Amell, Mr. Pilar, and Mr. Wheeler. *Prereq.*: Special permission. Credits to be arranged.

CIVIL ENGINEERING

J. HAROLD ZOLLER, *Chairman*

A candidate for the degree of Master of Science in Civil Engineering must have completed a course of study equivalent to that required by this department for the baccalaureate degree or he must take specified courses in the areas of deficiency without credit. An oral final examination is required of all candidates.

A candidate for the Master's degree will normally complete a thesis for not less than 6 nor more than 9 hours of credit. With the permission of the department, a student may be permitted to substitute approved course work for the thesis requirement. In this event he must also submit to his examining committee a paper written in one of his courses, which shall be the equivalent of a thesis in style and quality, but not in scope. One copy of the thesis or paper is required by the department.

Courses numbered above 70 will be offered biennially or upon demand.

51. HIGHWAY ENGINEERING. The economics of location, planning, and design of highways and city streets; methods of construction, maintenance, and specifications governing the various types of surfaces. The administration and methods of financing highway systems. Selected problems of planning and design are studied in the laboratory. Mr. Skelton. *Prereq.*: C. E. 6 and E. E. 17 or C. E. 15. 3 lec.; 1 lab.; 4 cr.

52. FLUID MECHANICS. Properties of fluids; fluid statics; flow of incompressible and compressible ideal fluids; flow of real fluids; and measurement of fluid properties. Mr. Dawson. *Prereq.*: M. E. 35 and Math 23. 3 lec.; 3 cr.

53. FLUID MECHANICS LAB. Experimental study of fluid properties and their relation to the solution of practical problems. Mr. Dawson. *Prereq.*: C. E. 52 as a prerequisite or concurrently. 1 lab.; 1 cr.

54. SOIL MECHANICS. Soil classification, physical properties including permeability, compressibility, bearing capacity, settlement, and shear resistance are related to the principles underlying the behavior of soils subjected to various loading conditions. Underground exploration and typical foundation problems are included. Mr. Skelton. *Prereq.*: C. E. 51 and 59, or permission of the instructor. 3 lec.; 1 lab.; 4 cr.

56. STEEL DESIGN. The design of members and connections; tension and compression members, beams, plate girders; riveted, bolted, and welded joints. Mr. Alling. *Prereq.*: C. E. 17 and 25. 2 lec.; 1 design period; 3 cr.

57. THEORY OF INDETERMINATE STRUCTURES. Beam and truss deflections. The analysis of continuous beams and rigid frames by classical and modern methods; indeterminate trusses. Mr. Alling. *Prereq.*: C. E. 56 or C. E. 27 and M. E. 10. 3 lec.; 1 design period; 4 cr.

59. REINFORCED CONCRETE DESIGN. The principles of reinforced concrete, including rectangular beams, slabs, T-beams, columns, footings, retaining walls. Mr. Alling. *Prereq.*: C. E. 57 or C. E. 28 as a prerequisite or concurrently. 2 lec.; 1 design period; 3 cr.

60. STRUCTURAL ENGINEERING. The planning and design of determinate and indeterminate structures. Introduction to modern design theories; prestressed concrete, plastic theory of steel and reinforced concrete. Mr. Alling. *Prereq.*: C. E. 57 and C. E. 59. 2 lec.; 1 design period; 3 cr.

63-64. HYDRAULIC AND SANITARY ENGINEERING. Precipitation, water losses, run-off, drainage areas, stream flow, water power estimates, hydraulic turbines, dams and waterways; the sources, quantity, quality, and sanitary aspects of public water supplies; the methods of purification and distributing systems; the theory and problems of sewerage, the principles governing the disposal of sewage, and the various methods of sewage treatment. Mr. Bowler. *Prereq.*: C. E. 52. C. E. 63: 3 lec.; 1 lab.; 4 cr. C. E. 64: 3 lec.; 2 lab.; 5 cr.

71. COMMUNITY PLANNING. An introduction to the subject of community planning. Social, economic, and physical factors affecting community planning; content and extent of desirable community planning programs, including purpose and scope, the preliminary survey, elements of community land planning, the master plan, transportation systems, street patterns and traffic, motor

vehicle parking, airport sites, public building sites, parks and recreational facilities, zoning, control of land sub-division, neighborhood centers, housing, legal, financial and economic problems, and redevelopment of blighted areas. Mr. Dawson. *Prereq.*: Permission of the instructor. 3 lec.; 3 cr.

74. **TIMBER DESIGN.** Properties and characteristics of structural woods, connection methods, design of timber members and connections in beams, columns, and trusses, and glued laminates of wood. Mr. Alling. *Prereq.*: C. E. 25 and C. E. 56 and permission of the instructor. 1 lec.; 1 design period; 2 cr.

77. **CONTRACTS, SPECIFICATIONS, AND PROFESSIONAL RELATIONS.** A study of the essential elements required in engineering contracts; the purposes and content of specifications; professional conduct, relations, and ethics; and estimating by means of quantity surveys and unit cost methods. Mr. Dawson. *Prereq.*: Permission of the instructor. 3 lec.; 3 cr.

78. **STRUCTURAL MEMBERS.** Selected problems in the analysis and design of structural members, such as beams on elastic foundations, curved beams, beam columns, buckling, torsion. Mr. Alling. *Prereq.*: C. E. 56 and permission of the instructor. 3 lec.; 3 cr.

80. **BITUMINOUS MATERIALS.** A study of the origin, physical characteristics, and uses of those bituminous materials which are normally used in highway construction. Theories of load distribution in flexible pavements, and design procedures by the tri-axial method, CBR method, Hveem method, Marshall method, and the Hubbard-Field Stability method are studied. Standard tests on bituminous materials and mixes are performed in the laboratory. Mr. Zoller. *Prereq.*: C. E. 51 or permission of the instructor. 1 lec.; 1 lab.; 2 cr.

101, 102. **CIVIL ENGINEERING PROBLEMS.** A special course designed to make possible the study and investigations of problems of Civil Engineering selected to meet the needs of the student. *Prereq.*: Permission of the instructor. 2 or 3 cr.

103-104. **SOIL MECHANICS.** The physical and mechanical properties of soil in relation to engineering structures. The theory of consolidation, shearing resistance, bearing capacity, settlement, earth pressure, and seepage studies. Mr. Skelton. *Prereq.*: C. E. 54 and permission of the instructor. 3 cr.

105. **SOIL TESTING FOR ENGINEERING PURPOSES.** Arranged to cover the essential soil tests for engineering purposes. Tests for the physical properties include: permeability, capillarity, compressibility, rate and magnitude of consolidation, and shearing resistance. Mr. Skelton. *Prereq.*: Permission of the instructor. 2 to 4 cr.

106. **FOUNDATION ENGINEERING.** Application of the principles of soil mechanics to selection of type of substructure, foundation construction methods, exploratory soil studies, stability analysis, earth dam and tunnel construction, and underpinning operations. Mr. Skelton. *Prereq.*: C. E. 54 and permission of the instructor. 3 cr.

111-112. **ADVANCED HYDRAULICS.** Dimensional analysis, dynamic similarity, mechanics of viscous fluids, fluid flow in pipes, non-uniform flow, alternate stages of flow in open channels, hydraulic jump, and their application to engineering practice. Mr. Bowler. *Prereq.*: C. E. 63 and C. E. 64 and permission of the instructor. 3 cr.

113-114. **EXPERIMENTAL HYDRAULICS.** Experimental techniques and laboratory practice. Experimental studies of the fundamental phenomena of liquid flow. Mr. Dawson. *Prereq.:* C. E. 52 and permission of the instructor. 3 cr.

115-116. **ADVANCED HYDRAULIC AND SANITARY ENGINEERING.** Hydrology, hydraulics of river flow, flood flows, design of reservoirs, flood control, river control, and hydraulic and sanitary structures. Water treatment and sewage treatment practices. Mr. Bowler, Mr. Dawson. *Prereq.:* C. E. 63 and 64 and permission of the instructor. 3 cr.

121-122. **ADVANCED STRUCTURAL ANALYSIS AND DESIGN.** Theories of structural action and their application to the design of complex structures. Mr. Alling. *Prereq.:* C. E. 60 and permission of the instructor. 3 cr.

123. **INDETERMINATE STRUCTURES.** The analysis of continuous beams, rigid frames, and redundant trusses by classical and modern methods, such as elastic weights, method of work, slope deflection, moment distribution, and column analogy. Mr. Alling. *Prereq.:* C. E. 57 and permission of the instructor. 3 cr.

129-130. **THESIS.** Hours and credits, from 6 to 9, are to be arranged.

DAIRY SCIENCE

KENNETH S. MORROW, *Chairman*

Students admitted to graduate study in Dairy Science are expected to have had satisfactory undergraduate preparation in Dairy Science, Animal Science, or other biological sciences.

Candidates majoring in Dairy Science will be required to pass an oral examination and prepare a thesis.

60. **DAIRY SEMINAR.** Recent agricultural experiment station and other literature covering the field of dairy production. Practice in looking up literature and in the preparation of oral and written reports. Staff. 2 lec.; 2 cr.

61. **A REVIEW OF DAIRY SCIENCE.** Subject matter covering the principles and practices relating to the latest information on dairy cattle breeding, feeding and management, and the processing and marketing of milk and its products. For teachers of Vocational Agriculture and other students with the permission of their advisers. Staff. Summer Session only; offered in 1960. Two hours' daily lec. and lab.; 2 cr.

62. **ADVANCED DAIRY SCIENCE.** Basic data, fundamental observations, and discussions of research contributing to the present status of the dairy industry. Mr. Moore. *Prereq.:* Adequate preparation in chemistry and bacteriology. 2 lec.; 2 cr.

63. **DAIRY CATTLE.** Purebred dairy cattle; breed history, pedigrees; family lines and methods of outstanding breeders; the application of the principles of genetics to the improvement of dairy cattle herd analysis. Mr. Morrow. 2 lec.; 1 lab.; 3 cr.

64. MILK PRODUCTION. Feeding and management of dairy animals, calf feeding, raising young stock, and feeding for economical milk production. Mr. Keener. 2 lec.; 1 lab.; 3 cr.

65. MARKET MILK. The producing, handling, and distributing of market and certified milk, dairy farm inspection, and control of milk supply. Mr. Moore. 2 lec.; 1 lab.; 3 cr.

66. ICE CREAM, BUTTER, AND CHEESE. The making, handling, and marketing of ice cream, butter, and cheese. Mr. Moore. 2 lec.; 1 lab.; 3 cr.

101. ANIMAL NUTRITION. Incidental lectures, assigned reading and laboratory practice in methods of research with major emphasis on protein and energy metabolism. Mr. Colovos. *Prereq.*: A major in Animal Science or Dairy Science or equivalent. 3 cr.

102, (102). ADVANCED DAIRY CATTLE. Special emphasis will be given to the analysis and formulating of breeding programs and to milk secretion and factors influencing the quantity and quality of milk. Mr. Morrow. *Prereq.*: A major in Animal Science or Dairy Science, or equivalent. 2 lec.; 1 lab.; 3 cr.

107. TECHNICAL CONTROL. Chemical and bacteriological laboratory methods used in the technical control of milk and milk products. Mr. Moore. *Prereq.*: Dairy Bacteriology. 2 lec.; 1 lab.; 3 cr.

109, 110. SPECIAL PROBLEMS IN DAIRY MANUFACTURE. Detailed study of some special phase of dairy manufacturing. Mr. Moore. *Prereq.*: A major in Dairy Science. Conferences and special assignments. 3 cr.

111, (111). SPECIAL PROBLEMS IN DAIRY PRODUCTION. Study of some special phase of breeding or feeding as related to dairy-herd management. Mr. Morrow, Mr. Keener. *Prereq.*: A major in Dairy Science or Animal Science, or equivalent. Conferences and special assignments. 3 cr.

112, (112). SPECIAL PROBLEMS IN ANIMAL NUTRITION. Library work, conferences, and written reports on selected problems in animal nutrition. Mr. Keener. *Prereq.*: Adequate preparation in animal nutrition. 3 cr.

THESIS. Hours and credits, from 6 to 10, are to be arranged.

ECONOMICS

ARTHUR W. JOHNSON, *Chairman*

Graduate work is offered in Economics leading to the Degree of Master of Arts.

Admission to graduate study in Economics is limited to students with a satisfactory undergraduate record. The prerequisite for graduate work consists of a minimum of 24 hours of undergraduate work in Economics and related fields of which at least 12 hours shall have been in Economics. The Economics requirement includes a year's work in Principles of Economics and one semester's work in Economics and Business Statistics. A student who has not

completed the semester of statistics may be admitted conditionally with the requirement that he pass (without credit) the course in Economics and Business Statistics given at the University of New Hampshire.

The candidate for a Master's degree must fulfill the general requirements of the Graduate School and the following departmental requirements: 18 semester hours in the Department of Economics in courses numbered above 100; a thesis, which may fulfill a maximum of six semester hours of the course requirements numbered above 100. The remaining twelve semester hours may be in the Department of Economics, in courses numbered above 50, or, with the consent of the major adviser, a maximum of nine semester hours will be accepted in courses numbered above 50 in related departments.

The thesis must be in form for presentation to the reading committee by May 1 of the year in which the degree is to be granted. No final examination is required.

51. **LABOR PROBLEMS.** Historical background and present status of labor organizations and problems. Labor-management relations and collective bargaining; economics of wages and employment; case studies. Mr. Hogan. *Prereq.:* Principles of Economics. 3 lec. or rec.; 3 cr.

52. **PUBLIC FINANCE.** Economic analysis of public expenditures, collection of public revenues, and debt policies of federal, state and local governments; evaluation of practices and techniques in financial administration of governments; analysis of taxation problems in the State of New Hampshire and New England. Mr. Rosen. *Prereq.:* Principles of Economics. 3 lec. or rec.; 3 cr.

53. **MONEY AND BANKING.** Study of the monetary and banking system with reference to monetary standards, value of money, commercial and non-commercial banking, and structure and policy of the Federal Reserve System. Mr. Degler. *Prereq.:* Principles of Economics. 3 lec. or rec.; 3 cr.

54. **ADVANCED MONEY AND BANKING.** Advanced monetary theory and some of the more practical aspects of modern banking. Mr. Degler. *Prereq.:* A satisfactory average in Money and Banking. 3 lec. or rec.; 3 cr. (Alternate years offered in 1960-61.)

55. **CORPORATIONS.** Study of the forms of business organization with special emphasis on the corporate system, combination, and concentration. Mr. Degler. *Prereq.:* Principles of Economics. 3 lec. or rec.; 3 cr.

56. **CORPORATION FINANCE.** Study of corporate securities, methods of financing, and financial policy. Mr. Degler. *Prereq.:* Principles of Economics. 3 lec. or rec.; 3 cr.

58. **PRINCIPLES OF INVESTMENT.** The general principles of investment. The problem of investment; investment characteristics of stocks and bonds; public utility, railroad, industrial, and government securities; protection of the investor; investment banking; and related problems. Mr. Degler. *Prereq.:* Principles of Economics. 3 lec. or rec.; 3 cr. (Alternate years not offered in 1960-61.)

63. **INTERNATIONAL TRADE.** Theory of international trade, foreign exchange, balance of international payments, tariffs and protection; the economic aspects of international relations with particular reference to recent policies. Miss Woodruff. *Prereq.*: Principles of Economics. 3 lec. or rec.; 3 cr.

64. **COMPARATIVE STUDY OF ECONOMIC SYSTEMS.** An examination of socialism, communism, capitalism, and modifications of these types, particularly as exemplified by leading nations. *Prereq.*: Principles of Economics or permission of the instructor. Miss Woodruff. 3 lec. or rec.; 3 cr.

73. **VALUE AND DISTRIBUTION.** An advanced course in economic theory. Emphasis is upon the theory of price and the distribution of income. Mr. Shafer. *Prereq.*: Principles of Economics. 3 lec. or rec.; 3 cr.

74. **THE ECONOMICS OF CONTEMPORARY AMERICAN BUSINESS.** The nature of business profits as molded by accounting; survey of the mechanisms yielding profits, including producing and inventory accumulation, credit expansion, net capital formation, etc.; the effects of these upon inflation, the value of money, labor management problems, the desire for tariffs, business cycles, farm problems, high-pressure selling, and other economic problems of the times; some evaluation of Neo-Classical and Keynesian schools of economic thought. Mr. Shafer. *Prereq.*: Principles of Economics. 3 lec. or rec.; 3 cr.

75. **NATIONAL INCOME.** The measurement, theory, and public policy applications of national income. Mr. Rosen. *Prereq.*: Econ. 2; 3 lec. or rec.; 3 cr.

76. **ECONOMIC FLUCTUATIONS. (Business Cycles).** Study of recurrent movements of prosperity and depression, with emphasis upon causes and public policy applications. Mr. Rosen. *Prereq.*: Econ. 2 and one additional semester course in Economics or permission of the instructor. 3 lec. or rec.; 3 cr.

151, 152. **LABOR SEMINAR.** Advanced study of labor markets, wage incentive systems, job evaluation, relation of wage policy to employment and problems raised by these and other factors in negotiating collective bargaining contracts. Collective bargaining studied as a means of establishing a system of industrial jurisprudence. Class discussion based primarily on case studies. Mr. Hogan. 3 lec. or rec.; 3 cr.

157-158. **HISTORY OF ECONOMIC THOUGHT.** A critical study of the development of economic concepts and ideas. Attention is given to the various schools of economic thought. Mr. Shafer. *Prereq.*: 18 hours of major credit in Economics and the consent of the instructor. 3 lec. or rec.; 3 cr.

177. **INSTITUTIONALISM.** The institutional approach in economic analysis; the theory of conflicts of interest, scarcity, and mutuality; theory of transactions; efficiency in relation to scarcity; futurity; habit and custom; sovereignty and legal foundations; reasonable value; some examination of the works of Locke, Hume, Veblen, Commons, Mitchell, Nourse, and others. Mr. Shafer. *Prereq.*: 18 hours of major credits in Economics and the consent of the instructor. 3 cr.

181, 182. **READING AND RESEARCH IN ECONOMICS.** With the advice and consent of the instructor, a student prepared by training and experience to do independent work may register for a reading and research course. The student will undertake assigned problems and readings under the guidance of the instructor. Hours and credits by arrangement.

- A. Economic History, Miss Woodruff
- B. International Trade, Miss Woodruff
- C. Economic Theory, Mr. Shafer
- D. Labor Economics, Mr. Hogan
- E. Public Finance, Mr. Rosen
- F. Money and Banking, Mr. Degler
- G. Corporations, Mr. Degler
- H. Accounting Theory, Mr. Johnson
- I. Marketing, Mr. Cronin
- J. National Income, Mr. Rosen
- K. Economic Fluctuations (Business Cycles), Mr. Rosen

THESIS. 6 cr.

EDUCATION

EVERETT B. SACKETT, *Chairman*

ADMISSION. (See also pp. 11-12.) For admission to graduate study in Education, a student must present, in addition to a Bachelor's degree, evidence of having satisfactorily completed, for Curriculum I, either an undergraduate major in Elementary Education or (a) a year of Educational Psychology or its equivalent, and (b) major subject preparation comparable to University of New Hampshire undergraduate requirements. For Curriculum II a student must be fully certified as a teacher or give other evidence of adequate preparation in psychology and the principles of education.

REQUIREMENTS. For the degree of Master of Education, 30 credits must be earned. Areas in which competence must be demonstrated, and courses suggested to aid in acquiring this competence, are listed under Curriculum I, unless the student is preparing for guidance counseling in which case Curriculum II is the guide.

Curriculum I

1. PRINCIPLES OF EDUCATION.
Ed. 59, or El. Ed. 95
2. GENERAL METHODS AND CURRICULUM.
Ed. 58 or 160, or El. Ed. 98.
3. SPECIAL METHODS.
Ed. 91 or 92, or El. Ed. 90 and 92.
4. TEACHING EXPERIENCE.
Ed. 94 or successful teaching experience.
5. MEASUREMENT.
Ed. 165.

6. ADVANCED EDUCATIONAL PSYCHOLOGY.
Ed. 150.
7. PHILOSOPHY OF EDUCATION.
Ed. 176.
8. DYNAMICS OF BEHAVIOR.
Psych. 89 or Psych. 141.

Curriculum II

1. EDUCATIONAL THEORY AND BACKGROUND.
Ed. 150 and Ed. 176.
2. DYNAMICS OF BEHAVIOR.
Psych. 89 or Psych. 141.
3. PSYCHOMETRICS.
Ed. 165 and Psych. 123.
4. PRACTICUM IN COUNSELING.
Psych. 105 and Ed. 120.
5. PROFESSIONAL INFORMATION AND TECHNIQUES.
Ed. 83, Ed. 117 and Ed. 118.

Students who meet the requirements described are free to select, subject to the approval of an adviser, the remainder of their work required for the degree from Education and subject-matter courses arranged to secure most effective preparation for the professional work they desire to pursue. Students will be able to choose from a variety of courses designed to be helpful: to students who are interested in increasing their teaching efficiency in the elementary school and the junior high school, as well as in the senior high school; to teachers and administrative officers who are interested in physical education activities; and to educational administrators and teachers who are preparing to enter fields of administration or supervision.

FINAL EXAMINATION. Near the end of thirty semester hours of work the candidate for the Master's degree in Education begins writing, with the help of the Chairman of the Master of Education Degree Committee, a group of statements which are his own stand on basic issues in education. The aim of the writing of these statements is to help the candidate to pull together the ideas and points of view he has taken from course work and his previous experience into his own consistent and working philosophy of education. When he finishes his courses and the writing of the complete set of statements, he defends these statements in an oral examination. If the oral examination is to be taken during the academic year, completed theses must be submitted on or before April 20; if the ex-

amination is scheduled for the summer, July 20 is the last date for submitting the completed theses. No more than two opportunities are permitted for the submission of the complete sets of statements to the Master of Education Degree Committee, and no more than two opportunities are permitted for the oral examination.

53, (53). THE HISTORY OF EDUCATIONAL IDEAS. All of the modern theories and practices and all of the present-day conflicts about education have their stems in the past. In this course some of the scholarship of the social sciences as well as the materials from the history of education will be related to contemporary educational viewpoints. A better understanding of the bases of American ideas about education should result from this approach. 3 cr. (*Offered in Extension and Summer Session only.*)

54, (54). EDUCATION IN FOREIGN COUNTRIES. In this course educational developments in selected foreign countries will be examined in relation to the cultural background and present-day needs of the people. Attention will be directed to the sociological and psychological factors that influence the educational policy and the structure of each national school system. 3 cr. (*Offered in Extension and Summer Session only.*)

57. PRINCIPLES OF LEARNING. Psychology of learning as it operates within the classroom. *Prereq.*: Education 41, required tests for teacher selection and permission of the department. 3 rec., 3 cr.

58, (58). PRINCIPLES OF TEACHING. The theories of learning studied in Education 57, with specific emphasis upon the following: organization of content, specific planning, and a study of procedures essential to the evaluation of the learning processes. *Prereq.*: Education 42 or 57, required tests for teacher selection, permission of instructor. Two 2-hour rec.-labs.; 3 cr.

59, (59). PRINCIPLES OF EDUCATION. American schools have developed, and are still developing, in unique forms quite unlike their European counterparts. Among Americans, however, there are basic disagreements concerning the direction our schools should take. This course deals with these conflicts of philosophy, the problems of American education, and research pertinent to these problems. 3 cr.

63, (63). AUDIO-VISUAL MATERIALS IN THE ELEMENTARY AND SECONDARY SCHOOLS. A course intended to give teachers a practical working knowledge of the use of various types of audio-visual materials. Particular attention will be given to the school journey, the school museum, film strips, glass slides, transcriptions, recording tapes, and radio broadcasts. The course will be centered around the problems which are common to the use of audio-visual materials in both elementary and secondary schools. A laboratory period of one hour each week is required in addition to the regular class period. Efforts will be made to arrange the laboratory time to meet the need of the student. 3 cr.

83. PRINCIPLES AND PRACTICES OF GUIDANCE. A first course which tries to help the student understand and utilize the philosophies and processes of guidance as they operate in his own behavior. Mr. Menge. *Prereq.*: Educational Psychology. 3 cr.

87. PRINCIPLES AND PROBLEMS OF SECONDARY-SCHOOL CURRICULUM REORGANIZATION. The course will be concerned with significant changes in secondary-school offerings, with special emphasis upon curriculum revision and techniques of revision. Mr. Koch. 3 cr.

102. PUBLIC SCHOOL ADMINISTRATION. For students who have had teaching or administrative experience, and are looking forward to further work as superintendent, principal, or department head. Emphasis will be placed upon the practical application of the following functions of public school administration: policy making, management, personnel, public relations, finances, housing, curricula, reporting, research. Mr. Sackett. 3 cr.

114. SEMINAR IN CURRICULUM STUDY. The techniques and procedures of curriculum development for the purpose of better meeting the educational needs of adolescents. Mr. Koch. 3 cr.

117. INFORMATIONAL MATERIALS IN GUIDANCE. A broad perspective of guidance materials, including follow-up studies, community surveys, and the *Dictionary of Occupational Titles*. Designed for teachers or prospective counselors working toward certification in guidance. 3 cr.

118. ORGANIZATION AND ADMINISTRATION OF GUIDANCE. An advanced course for teacher-counselors, counselors, and administrators who are interested in planning or reorganizing a guidance program. It will be conducted as a seminar, giving practice in group dynamics. *Prereq.*: Permission of the instructor. 3 cr.

120. EXPERIENCE IN COUNSELING. Vocational and educational counseling of adolescents under supervision. *Prereq.*: Ed. 117, 165 and Psych. 105. 1-4 cr.

122. PROBLEMS IN THE SUPERVISION OF HIGH SCHOOL TEACHING. Problems of human relations in curriculum development. Field research or library research is required. Designed for principals, superintendents, and the supervisors of cadet teachers. 3 cr.

125. EDUCATIONAL FINANCE AND BUSINESS MANAGEMENT. Aspects and principles of financing education, budgetary procedure, accounting, cost analysis, auditing school indebtedness, and financial reporting comprise the units to be studied. Experience in handling practical school finance problems will be part of the project work. *Prereq.*: A basic administration course or equivalent in experience. 3 cr.

131-132. RESEARCH PROBLEMS IN EDUCATION. 2 to 6 cr.

150. ADVANCED EDUCATIONAL PSYCHOLOGY. Special topics in the field of educational psychology with emphasis upon the learning process: (a) examination of learning situations in the classroom in the light of experimental research; (b) examination and evaluation of learning situations in the light of the major theories of learning. Mr. Koch. *Prereq.*: Educational Psychology. 3 cr.

160. ADVANCED STUDY IN PLANNING FOR TEACHING IN HIGH SCHOOL. An opportunity to study problems, principles, and techniques which are involved in planning for pupil learning in high school. *Prereq.*: For graduate students with teaching experience. 3 cr.

165. EDUCATIONAL TESTS AND MEASUREMENT. Testing theory and practice, concerned with a two-fold analysis of standardized tests and batteries, in terms of (a) their psychological, or factorial, meanings, and (b) their practical, or predictive, uses. Mr. Lohnes. 3 cr.

176. PHILOSOPHY OF EDUCATION. A study of current educational objectives and practices and the philosophical foundations upon which they are based. Mr. Marshall. 2 or 3 cr..

Courses in Problems in Teaching High-School Subjects

The following courses are devoted to a study of problems of objectives, selection, and organization of subject matter, teaching and testing techniques and classroom management in the teaching of the respective subjects. To be admitted into one of these courses the student must have completed, with a satisfactory grade, Planning for Teaching in High School, and, in addition, the courses in the subject and related subjects designated as prerequisites to the respective courses in this group. A student who desires to be considered for supervised teaching must complete with a satisfactory grade one of these courses in the subject in which he hopes to do supervised teaching.

AGRICULTURE-EDUCATION (AG-Ed) 89, 90. METHODS OF TEACHING FARM MECHANICS IN VOCATIONAL AGRICULTURE. Mr. Gilman. 1 cr.

AGRICULTURE-EDUCATION (AG-Ed) 92. PROBLEMS IN THE TEACHING OF VOCATIONAL AGRICULTURE. Mr. Barton. 3 cr.

ART-EDUCATION (ART-Ed) 91. PROBLEMS OF TEACHING ART IN ELEMENTARY SCHOOLS. Mr. Thomas. 3 cr.

ART-EDUCATION (ART-Ed) 92. PROBLEMS OF TEACHING ART IN SECONDARY SCHOOLS. Mr. Thomas. 3 cr.

BIOLOGY-EDUCATION (BI-Ed) 91. PROBLEMS IN THE TEACHING OF HIGH-SCHOOL BIOLOGY. Mr. Schaefer. 3 cr.

ENGLISH-EDUCATION (ENG-Ed) 91. PROBLEMS IN THE TEACHING OF HIGH-SCHOOL ENGLISH. Mr. Goffe. 3 cr.

GENERAL SCIENCE-EDUCATION (GS-Ed) 91. PROBLEMS IN THE TEACHING OF GENERAL SCIENCE. 3 cr.

HISTORY-EDUCATION (HIST-Ed) 91. PROBLEMS IN THE TEACHING OF HIGH-SCHOOL HISTORY. Mr. Long. 3 cr.

HOME ECONOMICS-EDUCATION (HE-Ed) 91. PROBLEMS IN THE TEACHING OF HIGH-SCHOOL HOME ECONOMICS. Miss Turney. 3 cr.

LANGUAGE-EDUCATION (LANG-Ed) 91. PROBLEMS IN THE TEACHING OF FOREIGN LANGUAGES IN THE HIGH SCHOOL. Mr. Leighton. 3 cr.

MATHEMATICS-EDUCATION (MATH-Ed) 91. PROBLEMS IN THE TEACHING OF HIGH-SCHOOL MATHEMATICS. Mr. Robinson. 3 cr.

MUSIC-EDUCATION (MUS-Ed) 91, 92. PROBLEMS IN THE TEACHING OF ELEMENTARY SCHOOL AND SECONDARY SCHOOL MUSIC. Mr. Whitlock. 3 cr.

PHYSICAL EDUCATION (PE-Ed) 91. PROBLEMS IN THE TEACHING OF PHYSICAL EDUCATION FOR WOMEN. Miss Newman. 4 cr.

Courses in Supervised Teaching

Supervised Teaching is not open to a graduate of another institution unless he first completes an approved program of Teacher Preparation in the University.

Applications for Supervised Teaching must be filed in the office of the Department of Education at least four weeks before the date at which Supervised Teaching begins. These applications must be approved by the Chairman of the Department of Education and the Coordinator of Supervised Teaching. An applicant must complete Education 58, and must have a sufficient background in a subject-matter field in which he is planning to teach. He must also complete a course in the problems of teaching in his major field. Supervised Teaching, as administered by the Department of Education, is a full-time job off campus for one semester.

Students may be enrolled for from 6 to 14 credits of work in Supervised Teaching. Students may count no more than 9 semester credits in Supervised Teaching toward the Master of Education degree.

EDUCATION-AGRICULTURE. (ED-AG) 93. SUPERVISED TEACHING IN HIGH-SCHOOL AGRICULTURE. *Prereq.*: Senior standing in Ag-Ed Curriculum.

EDUCATION-ART (ED-ART) 94. SUPERVISED TEACHING IN SECONDARY SCHOOL ART. *Prereq.*: Art-Ed 92.

EDUCATION-BIOLOGY (ED-BI) 93, 94. SUPERVISED TEACHING IN HIGH-SCHOOL BIOLOGY. *Prereq.*: Bi-Ed 91.

EDUCATION-COMMERCE (ED-CO) 94. SUPERVISED TEACHING IN HIGH-SCHOOL COMMERCIAL SUBJECTS.

EDUCATION-ENGLISH (ED-ENG) 94. SUPERVISED TEACHING IN HIGH-SCHOOL ENGLISH. *Prereq.*: Eng-Ed 91.

EDUCATION-GENERAL SCIENCE (E-GS) 94. SUPERVISED TEACHING IN GENERAL SCIENCE. *Prereq.*: GS-Ed 91.

EDUCATION-HISTORY (ED-HIST) 94. SUPERVISED TEACHING IN HIGH-SCHOOL HISTORY. *Prereq.*: Hist-Ed 91.

EDUCATION-HOME ECONOMICS (ED-HE) 94. SUPERVISED TEACHING IN HIGH-SCHOOL HOME ECONOMICS. *Prereq.*: HE-Ed 91.

EDUCATION-LANGUAGE (ED-LANG) 94. SUPERVISED TEACHING IN HIGH-SCHOOL FRENCH. *Prereq.*: Lang-Ed 91.

EDUCATION-LATIN (ED-LAT) 94. SUPERVISED TEACHING IN HIGH-SCHOOL LATIN.

EDUCATION-MATHEMATICS (ED-MATH) 94. SUPERVISED TEACHING IN HIGH-SCHOOL MATHEMATICS. *Prereq.*: Math-Ed 91.

EDUCATION-MUSIC (ED-MUS) 93, 94. SUPERVISED TEACHING IN ELEMENTARY AND SECONDARY SCHOOL MUSIC.

EDUCATION-PHYSICAL EDUCATION (ED-PE) (92), 92. DIRECTED TEACHING OF PHYSICAL EDUCATION FOR WOMEN. *Prereq.*: PE-Ed. 91 or concurrently. 1 lec. or rec.; 2 r-hr. labs.; 3-6 cr.

EDUCATION-PHYSICAL EDUCATION (ED-PE) 93, (93). DIRECTED TEACHING IN PHYSICAL EDUCATION.

EDUCATION-PHYSICAL EDUCATION (ED-PE) 94. SUPERVISED TEACHING OF PHYSICAL EDUCATION IN THE FIELD.

EDUCATION-SOCIOLOGY (ED-SOC) 94. SUPERVISED TEACHING IN HIGH-SCHOOL SOCIOLOGY. *Prereq.*: Hist-Ed 91.

Elementary Education

Courses in Elementary Education are given during the Summer Session and in Extension.

67. CHILDREN'S LITERATURE. 3 cr.

68. THE TEACHING OF ELEMENTARY-SCHOOL SOCIAL STUDIES. 3 cr.

74. REMEDIAL READING. 3 cr.

78. ADVANCED REMEDIAL READING CLINIC. 3 cr..

90. WORKSHOP IN READING. 4 cr.

92. WORKSHOP IN ARITHMETIC. 4 cr.

95. WORKSHOP IN PRINCIPLES AND PRACTICES OF THE ELEMENTARY SCHOOL. 4 cr.

98. WORKSHOP IN ELEMENTARY-SCHOOL CURRICULUM PROBLEMS. 3 cr.

ELECTRICAL ENGINEERING

ALDEN L. WINN, *Chairman*

To be admitted to graduate study in Electrical Engineering a student should have completed work in his major field equivalent to that required of undergraduates at the University of New Hampshire. With the consent of the department a student may be permitted to substitute approved course work for the thesis requirement. If a thesis is presented, one additional copy is required by the department.

Students who plan to take graduate work in Electrical Engineering are expected to consult with the department adviser in

order to plan their programs. Courses numbered below 100 are offered annually. Courses numbered above 100 are offered in sequences best suited to the needs of the graduate students who are in residence. Therefore, students who plan to take graduate work in Electrical Engineering should consult with the department chairman in order to plan a program and initiate a sequence. A final examination is required of all candidates for the Master's degree.

Permission of the instructor is required for enrollment in all Electrical Engineering graduate courses.

51-52. INDUSTRIAL ELECTRONICS FUNDAMENTALS. E. E. 51: Basic principles of electronic devices and associated circuits. E. E. 52: Application of electronics to industrial processes. *Prereq.:* Electrical Engineering Fundamentals. Limited to students not registered in the Electrical Engineering curriculum. Mr. Frost. 2 rec.; 1 lab.; 3 cr.

58. ELECTRONIC SYSTEMS ANALYSIS AND DESIGN. Advanced techniques in network and systems analysis; use of complex frequency and signal flow graphs; coding, transfer and storage of information. Mr. Frost. 3 rec.; 3 cr.

60. ADVANCED CIRCUIT THEORY. Steady state and transient analysis, derivation of fundamental formulas and constants; application of LaPlace transforms. Mr. Nulsen. 3 rec.; 1 conf.; 4 cr.; when offered without conference period, 3 cr.

62, (62). ILLUMINATION. Radiation, fundamental processes in gases, atomic spectra, sources of visible and near visible energy, lamp circuitry, lighting and wiring design, control of light, photometry, and color. Mr. Murdoch. 3 rec.; 3 cr. (Not offered in 1960-61.)

70, (70). ELECTRICAL ENGINEERING PROJECTS. A laboratory or advanced study course. Each student will either join one of the departmental research projects or engage in a project which is in one of the following areas of current staff interest: Acoustics and Electronic Systems (Mr. Frost), Control Systems (Mr. Blanchard, Mr. Clark), Illumination (Mr. Murdoch), Magnetic Amplifiers (Mr. Melvin), Non-linear Analysis (Mr. Hraba), Semiconductors (Mr. Winn), and Transient Analysis (Mr. Nulsen). Admission to the course will be limited to those accepted by a staff member. 1-4 conf. or 1-2 lab.; 1-4 cr.

78. INDUSTRIAL ELECTRONICS. Analysis and design of equipment for the measurement, instrumentation, and control of industrial processes; introductory theory of closed loop systems. Mr. Blanchard, Mr. Clark. 3 rec.; 1 lab.; 4 cr.

80, (80). ENGINEERING ANALYSIS. The basic principles and analytical methods employed in the solution of complex problems in the various branches of engineering. Mr. Hraba. 3 rec.; 3 cr.

82. CONTROL SYSTEMS. Fundamental principles involved in the design and analysis of feedback control systems. Mr. Clark. 3 rec.; 3 cr.; or 3 rec. and 1 lab.; 4 cr.

103-104. FIELDS AND WAVES. Electromagnetic fields and waves. Mr. Hraba, Mr. Frost. 3 rec.; 3 cr. or 4 cr. with conference.

105. PULSED CIRCUIT ANALYSIS. Analysis and design of pulsed circuits; investigation of systems which use pulsed circuit techniques. Mr. Winn. 3 rec.; 3 cr.

106. ANTENNAS. Theory and design of electromagnetic radiating systems. Mr. Frost. *Prereq.*: Fields and Waves. 3 rec.; 3 cr.

107-108. TRANSMISSION AND DISTRIBUTION OF ELECTRIC POWER. Line characteristics; steady-state performance; symmetrical components; lightning and over-current protection; relaying. Mr. Goodrich. 3 rec.; 3 cr.

109-110. ADVANCED NETWORK THEORY. Emphasis on the various methods of analysing and synthesizing linear networks. Messrs. Winn, Hraba, Blanchard. 3 rec.; 3 cr.; or 3 rec. and 1 conf.; 4 cr.

111. NONLINEAR NETWORKS. Analysis of networks with nonlinear and time-varying parameters. Mr. Hraba. 3 rec.; 3 cr.; or 3 rec. and 1 conf.; 4 cr.

113-114. PRINCIPLES OF SERVOMECHANISMS AND CONTROL. General open-loop and closed-loop control; design of feedback control systems; steady-state and transient response; stability criteria. Mr. Blanchard. *Prereq.*: Advanced Circuit Theory. E. E. 113: 3 rec.; 3 cr. E. E. 114: 2 lab. or seminar periods; 3 cr.

115. APPLIED ACOUSTICS. The propagation of acoustical waves in elastic media, characteristics of electro-acoustical transducers, architectural acoustics. Mr. Frost. 3 rec.; 3 cr.; or 3 rec. and 1 lab. or conf.; 4 cr.

117. ADVANCED ANALYSIS OF ALTERNATING-CURRENT MACHINERY. Steady state analysis of synchronous and induction machines. Mr. Hraba. 3 rec.; 3 cr.

118. ANALYSIS OF DYNAMO MACHINES UNDER TRANSIENT CONDITIONS. Analysis of the operation of alternating and direct-current machines with changing voltages and loads. Mr. Hraba. *Prereq.*: E. E. 117; 3 rec.; 3 cr.

120. ELECTRICAL ENGINEERING PROJECTS. Advanced studies in a specialized field of electrical engineering. Electrical Engineering Staff. Consent of instructor required. 1 to 3 conferences or laboratory periods; 1 to 3 cr.

130. CIRCUIT THEORY OF SOLID-STATE DEVICES. Equivalent circuit theory for transistors and other solid-state devices. Analysis and design of circuits containing solid-state elements. Mr. Winn. 3 rec.; 3 cr.

135. NON-LINEAR MAGNETIC DEVICES. Magnetic amplifiers with and without feedback; magnetic devices as modulators, frequency multipliers, and in switching circuits; modern theory of magnetism; properties of square-loop magnetic material. Mr. Melvin. Mr. Clark. 3 rec.; 3 cr.

140. INFORMATION THEORY. Introduction to probability theory and mathematical statistics; random noise in linear and non-linear circuits; Shannon's theory of information. Mr. Melvin. 3 rec.; 3 cr. (not offered in 1960-61.)

150. PRINCIPLES OF MICROWAVE SYSTEMS. Wave propagation in free space; dielectrics and conductors; normal modes of waveguides and cavities; interactions between traveling waves and electrons; generation at high frequencies. Mr. Frost. 3 rec.; 3 cr.; or 3 rec. and 1 lab. or conf.; 4 cr.

THESIS. Credits to be arranged. 6-10 cr.

ENGLISH

SYLVESTER H. BINGHAM, *Chairman*

For admission to graduate study in English an applicant must present an academic record that shows he is prepared for advanced work in English and American literature.

Special requirements for the Master's degree:

The student who is a candidate for a Master's degree in English must earn 30 credits: no more than 12 in literature courses open to undergraduate students (those numbered 55-99); at least 12 in literature courses numbered 155-199; and 6 credits in a thesis.

A reading knowledge of French, German, or Latin is required of the candidate.

A student taking a course numbered 155-199 other than a seminar must register for the graduate course and pass, in partial fulfillment, with a grade of B or better, the corresponding undergraduate course numbered 55-99; at the same time he must do additional work assigned by his instructor and prepare a paper on an agreed subject connected with his study. A student should not register for a graduate course if he has previously taken the corresponding undergraduate course.

If a student intends to complete his work for the Master's degree in one year, he should register for 3 thesis credits each semester.

55, 56. CHAUCER. Mr. Underwood. 3 lec.; 3 cr.

57, 58. SHAKESPEARE'S PLAYS. The major histories, comedies, and tragedies. Mr. Hennessy. 3 lec.; 3 cr.

59. MILTON. Mr. Schultz. 3 lec.; 3 cr. (Alternate years; not offered in 1960-61.)

60. BOSWELL'S JOHNSON. Mr. Maynard. 3 lec.; 3 cr. (Alternate years; not offered in 1960-61.)

61. WORDSWORTH. Mr. Miller. 3 lec.; 3 cr. (Alternate years; offered in 1960-61.)

62. BROWNING. Mr. Daggett. 3 lec.; 3 cr. (Alternate years; not offered in 1960-61.)

63, 64. ENGLISH LITERATURE IN THE SIXTEENTH CENTURY. Mr. Schultz. 3 lec.; 3 cr. (Alternate years; offered in 1960-61.)

65, 66. ENGLISH LITERATURE IN THE SEVENTEENTH CENTURY. Mr. Towle. 3 lec.; 3 cr. (Alternate years; not offered in 1960-61.)

67, 68. ENGLISH LITERATURE IN THE EIGHTEENTH CENTURY. Mr. Maynard. 3 lec.; 3 cr. (Alternate years; offered in 1960-61.)

69, 70. THE ENGLISH ROMANTIC PERIOD. Wordsworth, Coleridge, Lamb; Byron, Shelley, Keats, Hazlitt, DeQuincey. Mr. Miller and Mr. Heyworth. 3 lec.; 3 cr. (Alternate years; not offered in 1960-61.)

71, 72. VICTORIAN PROSE AND POETRY. Major non-fictional prose from Carlyle to Stevenson and major poetry from Tennyson to Hardy. Mr. Hennessy. 3 lec.; 3 cr. (Alternate years; offered in 1960-61.)

73, 74. BRITISH LITERATURE OF THE TWENTIETH CENTURY. Mr. Daggett. 3 lec.; 3 cr. (Alternate years; offered in 1960-61.)

75. NEW ENGLAND RENAISSANCE. Emerson, Thoreau, and other transcendentalists. Mr. Daggett. 3 lec.; 3 cr. (Alternate years; offered in 1960-61.)

76. AMERICAN NOVEL IN THE NINETEENTH CENTURY. Mr. Webster. 3 lec.; 3 cr. (Alternate years; offered in 1960-61.)

77. AMERICAN POETRY OF THE NINETEENTH CENTURY. Mr. Daggett. 3 lec.; 3 cr. (Alternate years; not offered in 1960-61.)

79, 80. AMERICAN LITERATURE OF THE TWENTIETH CENTURY. Mr. Towle. 3 lec.; 3 cr. (Alternate years; not offered in 1960-61.)

81, 82. INTRODUCTION TO ENGLISH DRAMA. The development of English drama, exclusive of Shakespeare, from the Middle Ages to the present. Mr. Hennessy. 3 lec.; 3 cr. (Alternate years; not offered in 1960-61.)

83, 84. THE ENGLISH NOVEL OF THE EIGHTEENTH AND NINETEENTH CENTURIES. Mr. Bingham and Mr. Miller. 3 lec.; 3 cr. (83 not offered in 1960-61.)

155, 156. CHAUCER. 3 lec.; 3 cr.

157, 158. SHAKESPEARE. 3 lec.; 3 cr.

159. MILTON. 3 lec.; 3 cr. (Alternate years; not offered in 1960-61.)

160. BOSWELL'S JOHNSON. 3 lec.; 3 cr. (Alternate years; not offered in 1960-61.)

161. WORDSWORTH. 3 lec.; 3 cr. (Alternate years; offered in 1960-61.)

162. BROWNING. 3 lec.; 3 cr. (Alternate years; not offered in 1960-61.)

163, 164. ENGLISH LITERATURE IN THE SIXTEENTH CENTURY. 3 lec.; 3 cr. (Alternate years; offered in 1960-61.)

165, 166. ENGLISH LITERATURE IN THE SEVENTEENTH CENTURY. 3 lec.; 3 cr. (Alternate years; not offered in 1960-61.)

167, 168. ENGLISH LITERATURE IN THE EIGHTEENTH CENTURY. 3 lec.; 3 cr. (Alternate years; offered in 1960-61.)

169, 170. THE ENGLISH ROMANTIC PERIOD. 3 lec.; 3 cr. (Alternate years; not offered in 1960-61.)

171, 172. VICTORIAN PROSE AND POETRY. 3 lec.; 3 cr. (Alternate years; offered in 1960-61.)

173, 174. BRITISH LITERATURE OF THE TWENTIETH CENTURY. 3 lec.; 3 cr. (Alternate years; offered in 1960-61.)

175. THE NEW ENGLAND RENAISSANCE. 3 lec.; 3 cr. (Alternate years; offered in 1960-61.)

176. THE AMERICAN NOVEL IN THE NINETEENTH CENTURY. 3 lec.; 3 cr. (Alternate years; offered in 1960-61.)

177. AMERICAN POETRY OF THE NINETEENTH CENTURY. 3 lec.; 3 cr. (Alternate years; not offered in 1960-61.)

179. 180. AMERICAN LITERATURE OF THE TWENTIETH CENTURY. 3 lec.; 3 cr. (Alternate years; not offered in 1960-61.)

181, 182. AN INTRODUCTION TO ENGLISH DRAMA. 3 lec.; 3 cr. (Alternate years; not offered in 1960-61.)

183, 184. THE ENGLISH NOVEL OF THE EIGHTEENTH AND NINETEENTH CENTURIES. 3 lec.; 3 cr. (183 not offered in 1960-61.)

185. 186. SEMINAR. Problems in Medieval Literature. Mr. Underwood. 3 cr. (Not offered in 1960-61.)

187. SEMINAR. Literature and Religious Philosophy, 1570 to 1670. Mr. Schultz. 3 cr.

THESIS. 6 cr.

ENTOMOLOGY

JAMES G. CONKLIN, *Chairman*

For admission to graduate study in Entomology an applicant is expected to have had adequate preparation in undergraduate Entomology and related sciences. Students lacking the necessary background courses may be required to complete certain courses which do not carry graduate credit before they are admitted to candidacy for a degree.

The program of graduate study is designed to meet the needs of those students who are planning to take further work leading to a career in professional Entomology.

A thesis is required of all candidates for the Master's Degree.

54. MEDICAL ENTOMOLOGY. Insects and arachnids in relation to public health. The more important disease carriers, their biologies, and means of control. Adapted especially for students who are interested in public health or medicine. Mr. Bickler. 2 lec.; 1 lab.; 3 cr.

57-58. ADVANCED ENTOMOLOGY. The anatomy and physiology of insects. Systematic Entomology. Mr. Conklin, Mr. Bickler, Mr. Lee. Open to others than Entomology majors by permission of the Chairman of the Department. 2 lec.; 2 lab.; 4 cr.

59-60. ADVANCED ECONOMIC ENTOMOLOGY. Problems in applied Entomology. The literature of Economic Entomology. Investigational methods. Studies

of the specialized phases of Entomology. Mr. Conklin, Mr. Blickle, Mr. Lee. Required of Entomology majors. Open to others than Entomology majors by permission of the Chairman of the Department. 1 to 3 cr.

101, 102. GRADUATE ENTOMOLOGY. Mr. Conklin, Mr. Blickle, Mr. Lee. Hours and credits to be arranged.

103, 104. GRADUATE ENTOMOLOGY. THESIS. Mr. Conklin, Mr. Blickle, Mr. Lee. Hours and credits to be arranged.

FORESTRY

PAUL E. BRUNS, *Chairman*

Students admitted to graduate study in Forestry are expected to have completed a course of study equivalent to that required for the degree of Bachelor of Science in Forestry. Those who lack undergraduate training in any of the necessary fields may be required to complete certain courses in these subjects without graduate credit before being admitted to candidacy for a degree.

Candidates for the Master's degree in Forestry must pass an oral examination. A thesis may or may not be required, as determined by the department staff.

101, 102. FOREST MANAGEMENT SEMINAR. Seminar discussions of current literature, plans and principles, and new developments in the general field of forest management. Mr. Bruns and members of the department. 2 rec.; 2 cr. *Prereq.*: Permission of the instructor.

104. APPROACH TO RESEARCH. A consideration of the meaning of science and the scientific method. The application of logic in the scientific method. A consideration of the general principles and techniques of scientific research. A general survey of statistical procedures as a tool for research. The organization of investigative work including problem analyses, working plans, and the preparation of reports. Mr. Husch, Mr. Wallace, Mr. Hocker, and others. 2 lec.; 2 cr. *Prereq.*: Permission of the instructor.

105, 106. UTILIZATION SEMINAR. Conferences, discussions and reports on assigned topics. Consideration of current literature, and developments in the general field of wood utilization. Mr. Swain. Two-hour seminar; 2 cr. *Prereq.*: Permission of the instructor.

109, 110. WILDLIFE MANAGEMENT SEMINAR. Discussions and assigned reports on current investigations and developments in wildlife management. Mr. Stevens. Two-hour seminar; 2 cr. *Prereq.*: Undergraduate courses in wildlife management.

131, 132. FOREST UTILIZATION. Methods of logging and milling in the chief lumber-producing regions of the United States; forest products, their manufacture and marketing; special problems of the lumber business. Mr. Swain. 2 lec.; 4-hr. lab.; 4 cr. *Prereq.*: Permission of the instructor.

133. FOREST PROTECTION. Protection of the forest from fire, insects, fungi, climatic extremes and other injurious agencies. Studies of forest conditions

leading to extensive damage, and of management and silvicultural practices for developing more resistant forest stands. Climatic change and weather behavior studies basic to forest protection. Mr. Wallace. 2 lec.; 1 lab.; 3 cr.

139, 140. **FOREST MANAGEMENT.** The management of forest areas on an economic and ecological basis. The integration and application of business methods and the technical phases of forestry. Preparation of management plans. Mr. Bruns. 2 lec.; 2 lab.; 4 cr. *Prereq.:* Permission of the instructor.

143. **MENSURATION.** Volume table construction and application, the study of growth and yield and methods of prediction. Application of graphic and statistical solutions to these problems. Mr. Husch. 2 lec.; 1 lab.; 3 cr. *Prereq.:* Permission of the instructor.

157, (157). **AERIAL PHOTOGRAMMETRY.** The application of aerial photogrammetrical techniques to specific forestry problems. A more detailed consideration of the use of aerial photographs for volume estimation including cull, volume tables, and species composition. The use of aerial photographs in fire control, range, timber and recreational management, road location, and allocation of cut. A consideration of the use of aerial photographs in designing large-scale resource inventories. Mr. Husch. 2 lec.; 2 cr. *Prereq.:* Permission of the instructor.

THESIS. Hours and credits to be arranged to meet the needs of the individual student. 6-10 cr. *Prereq.:* Graduate standing, and the permission of the instructor in the selected field of study.

GOVERNMENT

JOHN T. HOLDEN, *Chairman*

An applicant for admission to graduate study in Government must have completed 24 semester credits of work in the Social Sciences including a minimum of 12 credits in Government with an average grade of B or the equivalent in his government courses.

A candidate for the degree of Master of Arts in Government is required to complete at least 30 credits of work with a minimum of 18 credits in Government courses numbered 101-199 including the thesis; at least 3 credits in Government courses numbered 51-99; and a maximum of 9 credits in courses offered by related departments and numbered 51-99. No general or oral examination is required.

51. **ADMINISTRATION OF JUSTICE.** A study of the nature, sources, and problems of the law as distinguished from other forms of social control. In its approach the course is analytical and critical, tracing the origin and development of legal institutions from primitive times to the present and evaluating the modern role of judge, jury, and counsel in the administration of justice. In this way emphasis is given to the law in action, i.e., law as it is applied by courts and practiced by lawyers rather than as it is formulated by the legislative and executive branches. Mr. Dishman. 3 lec. or rec.; 3 cr.

52. **THE SUPREME COURT AND THE AMERICAN CONSTITUTION.** A case study of the American Constitution, stressing the basic constitutional principles on which the American political system is founded and their application to present-day social, political, and economic problems. In addition, emphasis will be given to the powers of Congress, the President, and the federal courts and to the constitutional limitations by which their respective powers are checked. Mr. Dishman. 3 cr.

55. **WORLD POLITICS.** A study of the basic driving forces in international relations including the nature of political power and its extension or limitation. Such topics as geopolitics, nationalism, ideology, imperialism, international economic relations, balance of power, warfare, regulation of arms, international law, and collective security will be discussed. Mr. Kuusisto. 3 lec. or rec.; 3 cr.

56. **FOREIGN POLICIES OF THE GREAT POWERS.** A study of fundamental factors influencing contemporary foreign policy formulation in the United States, the Soviet Union, the British Commonwealth, and other significant powers. The course will emphasize problems and choices confronting policy makers of these powers in dealing with issues involving the United Nations, regional organizations, Western Europe, Middle East, and Latin America. Mr. Kuusisto. 3 lec. or rec.; 3 cr.

57. **THE ADMINISTRATIVE PROCESS** The principal concepts of governmental administration, including theories of organization, administrative leadership, internal management, and administrative responsibility and control. Emphasis will be placed upon the relationship of group behavior and policy development to the administrative process. Mr. Knapp. Prereq.: Gov. 6 or Soc. 1. 3 lec. or rec.; 3 cr.

58. **NATURAL RESOURCES POLICY AND ADMINISTRATION.** The development and administration of public policy on land, water, and mineral resources. Special attention will be given to the historical development of governmental action in each of these areas, political conflicts on policy goals, and the administrative structure for carrying out current policies. Mr. Knapp. *Prereq.*: Gov. 5, 6. 3 lec. or rec.; 3 cr.

63. **POLITICAL THOUGHT IN THE WEST.** A survey of the principal political theories from Plato and Aristotle to the beginning of the modern liberal tradition. The course is designed to show the growth and development of political thinking and institutions in terms of the development of modern government. Special emphasis will be given to the development of the modern nation state and to its fundamental institutions. Mr. Holden. 3 lec. or rec.; 3 cr.

64. **MODERN POLITICAL THOUGHT.** A survey of modern Western political thought from the emergence of the nation state to the present. Special attention will be given to the meaning and growth of the basic patterns of thought on the Continent and in England, including liberalism, democracy, nationalism, socialism, communism, and fascism. American political thought will be traced from its English and European origins, stressing the more modern developments in federalism, judicial review, centralization, separation of powers, etc. Mr. Holden. 3 lec. or rec.; 3 cr. (Alternate years; not offered in 1960-61.)

65, 66. **RESEARCH IN GOVERNMENT PROBLEMS.** An individual research project in one of the fields of government, e.g., local or state administration, comparative government, international relations, international organization, political theory, politics, or public law to be prepared under the direction of

the instructor. Emphasis will be placed on the methods and sources of research in government. Mr. Dishman. 3 cr.

67. **PUBLIC POLICY AND INDUSTRY.** A study of the role of government in promoting and regulating, private industry and in operating its own enterprises in certain key sectors of the American economy. Emphasis will be placed on tariff policy and subsidies, the antitrust and "fair trade" law, unfair labor practices and the settlement of labor disputes, public utility regulation, and the operation of the Tennessee Valley Authority and other publicly-owned enterprises. The legal and political problems confronting New England will be given special stress. Mr. Dishman. *Prereq.*: Gov. 5, 6. 3 lec. or rec.; 3 cr. (Alternate years; not offered in 1960-61.)

69. **CONTEMPORARY SOUTH EAST ASIA.** A comparative study of the political and social development of South East Asia. The course will stress the significance of the role of independence and dependence; the competing influence of communism and Western democracy; the special significance of the role of China, India, Great Britain, and the United States. The states to be studied include the Philippines, Laos, Cambodia, Viet Nam, Viet Minh, Thailand, Burma, Malaya, and Indonesia. Mr. Holden. 3 lec. or rec.; 3 cr. (Alternate years; not offered in 1959-60.)

97, 98. **SEMINARS.** Current topics in government, political behavior, political history, public law, and international relations, conducted by faculty members of the department on a basis of rotation and interest. The courses are restricted to social science honor students and graduate students. Permission to enroll in and information about the courses may be secured from the Chairman of the Department. Mr. Holden, Mr. Dishman, Mr. Kuusisto, Mr. Knapp, Mr. Ford. Hours to be arranged. 3 cr.

READING AND RESEARCH IN GOVERNMENT AND POLITICAL SCIENCE. With the advice and consent of the instructor, graduate students in social science who demonstrate the ability to do independent work may register for a reading and research course. The student will attend the regular lectures, meet the required examinations, follow a prescribed reading program, and write a paper in lieu of a final examination. 3 cr.

152. **THE SUPREME COURT AND THE AMERICAN CONSTITUTION.**

154. **POLITICAL BEHAVIOR.** Mr. Dishman.

155. **TOPICS IN WORLD POLITICS.** Mr. Kuusisto.

156. **TOPICS IN FOREIGN POLICIES OF GREAT POWERS.** Mr. Kuusisto.

157. **ADMINISTRATIVE PROCESS.** Mr. Knapp, Mr. Ford.

158. **THE POLICY AND ADMINISTRATION OF NATURAL RESOURCES.** Mr. Knapp.

159. **PROBLEMS IN POLICY MAKING IN NATURAL RESOURCES.** Mr. Knapp.

163. **AMERICAN POLITICAL THOUGHT.** Mr. Holden.

164. **MODERN POLITICAL THOUGHT.**

167. **GOVERNMENT AND INDUSTRY.** Mr. Dishman.

169. **TOPICS IN ASIAN AND AFRICAN POLITICS.** Mr. Holden.

197, 198. **SEMINAR.** (See Government 97, 98). Mr. Holden, Mr. Dishman, Mr. Kuusisto, Mr. Knapp, Mr. Ford.

THESIS. To be arranged. 6-9 cr.

HISTORY

PHILIP M. MARSTON, *Chairman*

The candidate for admission to graduate study in History should present evidence of having satisfactorily completed at least 24 semester credits, as an undergraduate, in courses in History, not including courses open to freshmen, with a grade of C or better. The requirements for the degree of Master of Arts in History are those stated on pages 17, 18, and 19 of this catalogue. The completed thesis must be submitted by April 1 of the year in which the degree is to be granted. A final examination is not required.

51, 52. COLONIAL AND REVOLUTIONARY AMERICAN HISTORY. Colonial beginnings in America, national rivalries, the English colonies, the Revolution, and our national life to 1789. Early forms of Americanism in the making. Mr. Marston. 3 lec. or rec.; 3 cr. (Alternate years; offered in 1960-61.)

59, 60. SOCIAL AND CULTURAL HISTORY OF NEW ENGLAND. From the settlements to the present. The material and intellectual aspects peculiar to New England's social and cultural life. It is assumed that the student is familiar with the general history of New England. Mr. Marston. 3 lec. or rec.; 3 cr. (Alternate years; not offered in 1960-61.)

71, 72. HISTORY OF RUSSIA. A study of the development of the Russian state from its foundation to its present status as a world power. A major purpose of the course will be to increase the understanding of the present in terms of the past. In addition to political developments and foreign relations, emphasis will be placed on intellectual and ideological currents. Mr. Heilbronner. 3 lec. or rec.; 3 cr.

83, 84. THE FOREIGN RELATIONS OF THE UNITED STATES. Although primarily a study in the history of American diplomacy, as much attention as possible is given to the non-diplomatic aspects of foreign relations. Mr. Long. 3 lec. or rec.; 3 cr.

85, 86. TWENTIETH CENTURY AMERICA. A study of the history of the United States since 1890. Emphasis is placed on economic discontent and political protest from the Populist Revolt to date; and on the world conditions changing and molding United States foreign policy. Mr. Greenleaf. 3 lec. or rec.; 3 cr.

87, 88. NINETEENTH CENTURY AMERICA. An examination of the historical factors, both domestic and international, involved in the development of the American Republic, its institutions and people, from the inception of the new nation in 1789 to the emergence of the United States as a world power in 1900. Mr. Jellison. 3 lec. or rec.; 3 cr.

HISTORY-EDUCATION (HIST-ED). 91. PROBLEMS IN THE TEACHING OF HIGH-SCHOOL HISTORY AND OTHER SOCIAL STUDIES. Bibliography and new interpretations of history; the social studies curriculum, past and present; aims and objectives in the social studies; selection and organization of teaching material; teaching and testing techniques. Special emphasis on teaching American History and the Problems of American Democracy. Mr. Long. Open to students who have satisfactorily completed History of the United States; six credits in other history courses, exclusive of Introduction to Contemporary

Civilization; six credits from American Government, Principles of Economics or Principles of Sociology; and Principles and Problems of Teaching in the Secondary School. 3 lec. or rec.; 3 cr.

111, 112. SEMINAR IN THE HISTORY OF NEW ENGLAND. For Graduate Students who wish to specialize in some phase of New England history or the history of New Hampshire. The work is concerned primarily with the study and interpretation of source material and can be correlated with the preparation of a thesis. Mr. Marston. *Prereq.*: Permission of the instructor. 3 cr. (Alternate years; not offered in 1960-61.)

113, 114. SOURCES FOR THE STUDY OF COLONIAL AMERICAN HISTORY. For students who have taken Colonial and Revolutionary American History or the equivalent. Training in the methods of historical investigation and in the use of sources in the field of Colonial American History. The preparation of papers based on source materials alone. Mr. Marston. *Prereq.*: Permission of the instructor. 3 cr. (Alternate years; offered in 1960-61.)

119, 120. SEMINAR IN MODERN EUROPEAN HISTORY. Specialization in the study of the development of some major institutions and ideas which contributed to the structure and spirit of modern society. Research papers, relating to seminar discussions, will be required. Mr. Gilmore. *Prereq.*: A course in Modern European History and the permission of the instructor. 3 cr.

171, 172. SEMINAR IN RUSSIAN HISTORY. For students who wish to concentrate on specific problems in Russian History, such as the reform movements of the Nineteenth Century, the Russian Revolution, or intellectual movements in Russia. Emphasis will be placed on wide reading, both in primary and secondary works, on discussion of problems and on research papers. Mr. Heilbrunner. *Prereq.*: A course in Russian History or in Modern European History and the permission of the instructor. 3 cr.

THESIS. 6 cr.

HOME ECONOMICS

ANNA LIGHT SMITH, *Chairman*

Students admitted as candidates for the Master of Science degree in Home Economics, majoring in Nutrition, are expected to have completed a course of study equivalent to that required for the Bachelor of Science degree in Home Economics with a major in Foods and Nutrition at this University. However, students with good undergraduate records who have deficiencies in certain requirements may be admitted on condition that they complete specified courses without credit.

The candidate will be required to pass an oral examination and prepare a thesis. These credits may be from 6-10 depending upon the research problem involved.

The subject-matter fields for graduate study in Nutrition are: Foods and Nutrition, Agricultural and Biological Chemistry, or Bacteriology.

60. **FLAT PATTERN.** A study of the principles of developing designs from a basic pattern by the flat pattern method; and the development of original patterns and garments. *Prereq.:* H.E. 6. 2 3-hr. labs.; 3 cr.

61. **TAILORING.** An appreciation and application of tailoring principles to making and buying a tailored garment. *Prereq.:* H. E. 5 and one of the following: H. E. 38, 60, or 63. 2 lec.; 1 2-hr. lab.; 3 cr. (Alternate years; 1961-62.)

63. **DRAPING.** Principles of the draping processes in developing original costume designs. *Prereq.:* H. E. 5, Art 23, or permission of the instructor. 2 lec.; 1 2-hr. lab.; 3 cr.

64. **ADVANCED TEXTILES.** An introduction to the chemical and physical testing of textiles and assigned readings of technical literature in the field. *Prereq.:* H.E. 3, Chem. 45, Physics 1, and Bact. 1. 1 lec. or rec.; 2 2-hr. labs.; 3 cr.

65. **HISTORY OF COSTUME.** A study of costume (and textiles) from primitive times to the present and the relationship of the mores of each period to the development of the costume for the respective era. *Prereq.:* Soc. 1 or Psych. 1 or Ed. 41, 42. (Recommended Hist. 1. 2.) 3 lec. or rec.; 3 cr.

66. **COSTUME DESIGN AND FASHION ILLUSTRATION.** The development of some skill in the delineation of fashion figures, and the sketching of original costume designs derived from various sources of inspiration. *Prereq.:* H. E. 6 and H. E. 65. 2 2-hr. labs.; 2 cr.

68. **FUNDAMENTALS OF FASHION.** A study of economical, psychological, and sociological problems inherent in the field of fashion. A survey of the development of the fashion industry. A study of the outstanding persons in the field. *Prereq.:* Econ. 25, B. Ad. 46, Psych. 2, and Soc. 1. 3 lec. or rec.; 3 cr.

71. **EXPERIMENTAL FOODS.** A study of research and technological advances in the preparation and preservation of foods with an opportunity to experiment with specific foods in the laboratory. *Prereq.:* H.E. 15-16; Agr. Chem. 6 or parallel with Agr. Chem. 51. 1 lec.; 1 lab.; 2 cr.

73. **NUTRITION.** The application of the fundamental principles of the physiological and social sciences and their relationships to human nutrition. A knowledge of the nutritive value of foods, essential nutrients which promote growth and health, effect of food on the body, and adjustment of diet to varying income levels. *Prereq.:* Agr. Chem. 6 or parallel with Agr. Chem. 51. 2 lec.; 1 2-hr. lab.; 3 cr.

74. **NUTRITION IN HEALTH AND DISEASE.** A study of the modification of the normal diet and how nutrition is used as a therapeutic measure in the treatment of disease. *Prereq.:* H. E. 73. 2 lec.; 1 3-hr. lab.; 3 cr.

76. **NUTRITION SEMINAR.** Discussion of research and experimental work in human nutrition. Exploration of current periodicals, reports, and assigned readings. 3 rec.; 3 cr.

81, (82), (81), 82. **PROJECTS IN CHILD DEVELOPMENT.** Principles of guidance of young children. Nursery school procedures and practices. Discussion, conferences, and supplementary projects based upon special interests

of the student. Work with children in the Nursery School. Miss Rand. *Prereq.*: H.E. 25-26. 1 rec. or conference; 1-2 labs.; 1-3 cr. This course may be repeated.

83. HOME AND FAMILY LIVING. A discussion of the economic and social problems confronting the family and their relationships to various aspects of homemaking. Miss Turney. 3 lec. or rec.; 3 cr.

84. PERSONAL, FAMILY, AND COMMUNITY HEALTH. A study of the principles which promote healthful living and their application to members of the family and to routine home nursing care. 1 lec.; 1 lab.; 2 cr.

91. PRINCIPLES AND PROBLEMS OF HOME ECONOMICS EDUCATION. A study of the principles, procedures, and problems involved in developing school and community education with their implications for Home Economics. Miss Turney. *Prereq.*: Ed. 41-42, 52. 3 lec.; 3 cr.

93. NUTRITION EDUCATION. A study of the principles, procedures, and problems involved in the educational program for dietitians and nutritionists. Mrs. Smith. *Prereq.*: H.E. 73, 74 and Psych. 1, 47. 3 lec.; 3 cr.

94. SUPERVISED TEACHING IN HOME ECONOMICS. Eight weeks of supervised teaching. Miss Turney. *Prereq.*: Ed. 41, 42, 52, and H.E. 91. 6 cr.

96. SEMINAR IN HOME ECONOMICS EDUCATION. Discussion and follow-up of problems encountered by students after having completed supervised teaching. Assigned readings and discussions of the current literature in the field of Home Economics Education. For Seniors majoring in Teacher Preparation. Hours to be arranged. Miss Turney. 3 cr. Offered last eight weeks of second semester.

98. PRINCIPLES AND TECHNIQUES OF DEMONSTRATION. Discussion of the principles employed and experience in demonstrating equipment, preparation of food, etc. Staff. *Prereq.*: For Seniors in Home Economics. Hours to be arranged. 3 cr. Offered last eight weeks of second semester.

102. METHODS USED IN HUMAN NUTRITION RESEARCH. Presentation and discussion of recent methods and tests used to evaluate nutritional status. Mrs. Smith. *Prereq.*: Satisfactory preparation in Nutrition, Biological Chemistry, and Physiology. 3 cr.

103, 104. SPECIAL PROBLEMS. Laboratory work on special phases of (a) Foods, (b) Nutrition. The student will undertake assigned problems and readings under guidance of the instructor. Elective only upon consultation with Chairman of Department. Mrs. Smith. 3-6 cr.

106, 107. PROBLEMS IN CLOTHING AND TEXTILES. An opportunity for the mature student to investigate problems in the field through independent study, readings, research or cooperatively administered studies in industry or merchandising. Permission of the instructor. 3-6 cr.

THESIS. Hours and credits, from 6-10, to be arranged.

HORTICULTURE

WILLIAM W. SMITH, *Acting Chairman*

Students will find the department well equipped for fundamental research on horticultural problems. In addition to the general requirements for all graduate students, basic chemistry and plant science courses equivalent to those ordinarily required for a Bachelor's degree in Horticulture are prerequisites for admission to graduate study in Horticulture.

It is recommended that all graduate students complete work for the Master's degree. For those who wish to continue for the doctorate, in addition to the general requirements for the Ph.D. degree, the student shall satisfy the following departmental requirements:

Foreign Language. The student shall satisfy the Guidance Committee that he possesses a reading knowledge of two foreign languages which may be judged to be useful to him in his field of endeavor, before he may become eligible for candidacy.

Courses Without Credit. The student shall be required to take such courses, without graduate credit, as may be deemed necessary to better enable him to plan and carry out his research and interpret the results. Such requirements must be satisfied *before* the student may become eligible for candidacy.

Minors. One or two minors may be required in fields closely related to the topic of the student's dissertation. A minimum of 6 credits in one department may be accepted as a minor.

51, 52. **ADVANCED HORTICULTURE.** Subject matter in any phase of horticulture (with laboratory practice if desirable) to meet the needs of special students or groups of students. Staff. *Prereq.:* Permission to register from the Chairman of the Department. 1 to 3 cr.

53. **POMOLOGY: ORCHARD FRUITS.** Fundamental principles and experimental data and their applications to orchard problems including the establishment of orchards, soil management, water and fertilizer requirements, mineral deficiencies, training and pruning, fruit bud formation, pollination and fruit setting, thinning and winter injury. Mr. Eggert. 3 lec.; 3 cr.

54. **POMOLOGY: SMALL FRUIT CULTURE.** The culture and economic uses of the strawberry, raspberry, blackberry, blueberry, and grape. Each fruit is considered with relation to its history, propagation, planting, pruning, harvesting, marketing, insects and diseases, and domestic uses. Mr. Smith and Mr. Eggert. 2 lec.; 2 cr.

55. **SYSTEMATIC SURVEY OF FRUITS.** Important species and their botanical relationships. The history, distribution, and merits of each species, and the horticultural varieties developed from it. Staff. *Prereq.:* General Botany. 2 lec.; 2 cr. (Alternate years; not offered 1960-61.)

57. **SYSTEMATIC SURVEY OF VEGETABLES.** Important species of vegetables and culinary herbs and their botanical relationships. The history, distribution, and commercial merit of each species and the horticultural varieties developed from it. Mr. Kitchin. 2 lec.; 2 cr. (Alternate years; offered 1960-61.)

59. **GREENHOUSE MANAGEMENT.** Modern methods of greenhouse management including soils, watering, costs of production and marketing, and fundamentals of plant behavior under glass. Mr. Rogers. 2 lec.; 1 lab.; 3 cr.

60. **A REVIEW OF HORTICULTURE.** Subject matter covering the principles and practices relating to the culture of fruits, vegetables, and ornamentals. For teachers of Vocational Agriculture and other students with the permission of their advisors. Staff. Summer Session only; not offered in 1960. Two hours, daily lec. and lab.; 2 cr.

63. **THE DEVELOPMENT OF THE VEGETABLE INDUSTRY.** Similarities and differences in management of vegetable production for fresh market, processing, seed, and roadside sales and home use. The significance of the plant processes of photosynthesis, respiration, and translocation to the vegetable grower. Environmental factors of soil, temperature, and moisture as they affect vegetable production. The management and role of plant growing structures, seed testing, variety selection, nutrition, weed control, and irrigation in the home garden and commercial plantings. Mr. Kitchin. 2 lec.; 1 lab.; 3 cr.

64. **THE COMMERCIAL PRODUCTION, STORAGE, AND MARKETING OF SEVERAL DIFFERENT VEGETABLE CROPS.** The management and methods of culture, weed control, insect and disease control, nutrition, irrigation, and marketing of different types of vegetables and in different soils. The use and limitations of specialized equipment and chemicals together with a review of recent experimental work in vegetable production. Mr. Kitchin. 2 lec.; 1 lab.; 3 cr.

66. **NURSERY MANAGEMENT.** The development of the nursery business. Factors that influence the location of a nursery, layout of the plant, soil and site, types of plants, pest control, inspection, digging, grading, storage, packing, shipping, and sales. Mr. Eggert. *Prereq.:* Plant Propagation. 1 lec.; 1 lab.; 2 cr.

78. **COMMERCIAL GREENHOUSE CROPS.** A survey of the principal greenhouse crops and an intensive study of their individual culture. Mr. Rogers. *Prereq.:* Greenhouse Management. 2 rec.; 1 lab.; 3 cr.

91, 92. **HORTICULTURE SEMINAR.** A review of recent Horticultural literature and methods of investigational work. Students are required to prepare and present papers on selected topics. Staff. 1 lec.; 1 cr.

94. **PLANT BREEDING.** Application of the principles of genetics to practical plant breeding. Hybridization, chemical treatments, and selection as means of producing and improving varieties. Mr. Rogers. *Prereq.:* Zoology 61. 2 lec.; 1 lab.; 3 cr.

101-102. **METHODS OF PLANT RESEARCH.** A study of the methods used in laboratory and field in plant investigations including scientific equipment such as potentiometers, thermocouples, geiger counters, refractometers, spectrophotometers, etc., and their use; project outlines, bibliographies, procedures, interpretation of data and statistical analysis of results. Mr. Eggert and staff. *Prereq.:* Plant Chemistry. 2 rec.; 2 cr.

103. NUTRITION OF HORTICULTURAL PLANTS. The effect of soil management, fertilizers, mulching materials, and mineral deficiencies on the functioning and performance of horticultural plants. Staff. *Prereq.*: Soils, Plant Chemistry. 2 rec.; 2 cr.

104. ASEXUAL PROPAGATION OF PLANTS. The making, dissection, and critical examination of grafts, buds, cuttings, and layers of clones, especially as applied to fruit stocks. A study of regeneration, orientation, and compatibility of plant tissues. Mr. Smith. *Prereq.*: Plant Chemistry, Plant Physiology. 2 rec.; 2 cr.

105. FLOWER BUD FORMATION, POLLINATION, AND FRUIT SETTING. The influence of natural environmental factors, soil management, orchard fertilization, and resultant chemical composition of fruit plants on flower bud formation and alternate bearing; also, the effect of these and genetic factors on the production of fruit. Staff. *Prereq.*: Plant Chemistry, General Botany, Genetics. 2 lec.; 1 lab.; 3 cr. (not offered in 1960-61.)

109. INHERITANCE IN HORTICULTURAL PLANTS. Advanced problems in plant breeding and inheritance in various horticultural crops. Special emphasis on linkage and polyploids. *Prereq.*: Elementary genetics and plant breeding. Mr. Rogers. 3 lec.; 3 cr.

125, 126. RESEARCH IN HORTICULTURE. Staff. *Prereq.*: Hort. 102. (May be taken concurrently.) Credits to be arranged.

THESIS. To be arranged.

LANGUAGES

R. ALBERTO CASAS, *Chairman*

To be admitted to graduate study in Languages, the student must have met requirements substantially equal to those set up for the fulfillment of an undergraduate major in Languages at the University of New Hampshire.

The student must submit an acceptable thesis embodying the results of independent investigation (equivalent to 6 semester credits in courses primarily for graduate students).

The thesis must be presented before April 20 of the academic year in which the degree is to be granted. Before undertaking thesis work, the student must pass a comprehensive written examination in the language and literature of his major field of specialization. The examination will be given four times a year: January, May, August, and September. The candidate will be permitted only two opportunities to take this comprehensive examination. In case of failure in the first attempt, a re-examination may not be taken within the period of one semester.

A graduate student in Languages may take all his work in one language or in combinations of courses in two of the following languages: French, German, Latin, Spanish. The student must complete at least 30 credits of graduate work with a minimum of 15 credits in one of these languages, exclusive of the thesis. Six semester hours in courses in General Language and Literature, listed below, may be counted toward the degree.

A student taking a course numbered 151-199 must register for the graduate course and pass, in partial fulfillment, with a grade of B or better, the corresponding undergraduate course numbered 51-99; at the same time he must do additional work assigned by his instructor and prepare a paper on an agreed subject connected with his study. A student should not register for a graduate course if he has previously taken the corresponding undergraduate course.

General Language and Literature

51, 52. SURVEY OF MODERN EUROPEAN LITERATURE. The Renaissance, classicism, romanticism, and realism studied as international movements. Stress will be laid, not upon the details of each national literature, but upon the interdependence of the literature of the various countries. Conducted in English. Mr. Lepke. 3 rec.; 3 cr.

73. INTRODUCTION TO ROMANCE PHILOLOGY. The historical development of French and Spanish from Vulgar Latin. Phonology, morphology, syntax, semantics, etymology. Frequent reference is made to the spoken languages of today as well as to comparative semantics. Mr. Cryesky. *Prereq.*: Permission of instructor. 3 rec.; 3 cr. Alternate years; offered in 1960-61.)

LANGUAGES-EDUCATION (LANG-Ed) 91. PROBLEMS IN THE TEACHING OF MODERN LANGUAGE IN THE HIGH SCHOOL. The special objectives, methods, and devices of modern language teaching in high school. For prospective or actual teachers of French, German, and Spanish. Mr. Leighton. *Prereq.*: Intermediate French, German, Spanish; and grade of C or better in Principles and Problems of Teaching in the Secondary Schools, or one year's teaching experience.

French

51-52. FRENCH LITERATURE OF THE MIDDLE AGES AND THE RENAISSANCE. The various forms and masterpieces of French literature from the beginning to the year 1600. Reading in modern French versions. Mr. Parker. *Prereq.*: Fr. 5-6 or the equivalent. 3 lec. or rec.; 3 cr.

53-54. FRENCH LITERATURE OF THE SEVENTEENTH AND EIGHTEENTH CENTURIES. French literature from 1600 to the French Revolution. Topics studied include : the rise and development of the classical ideal, the masterpieces of the great writers of the age of Louis XIV, the decline and disintegration of classicism in the 18th century; the work and influence of Voltaire and Rous-

seau; the novel and drama in the 18th century. *Prereq.*: Fr. 6. 3 lec. or rec.; 3 cr.

55. FRENCH ROMANTICISM AND REALISM. The period from 1800 to 1870; Chateaubriand and Mme. de Stael; the Romantic School (Lamartine, Hugo, etc.); the historical novel and drama; early realists; romanticism and realism in works of Balzac, realism in the novel and drama (Flaubert, Augier, Dumas fils); Parnassian poetry (Laconte de Lisle, Baudelaire). *Prereq.*: Fr. 6. 3 lec. or rec.; 3 cr.

56. FRENCH LITERATURE FROM 1870 TO 1940. Principal topics; Zola and naturalism; the reaction from naturalism; the poetry of Verlaine, Rimbaud, Mallarme, and Claudel; Proust and Gide; surrealism; conservatives and innovators between the two World Wars. Mr. Parker. *Prereq.*: Fr. 55. 3 lec. or rec.; 3 cr.

57. CONTEMPORARY FRENCH PROSE. A study of the works of Proust, Gide, Mauriac, Sarte, Malraux, and Camus with attention to artistic, ethical, and moral concepts as related to the intellectual currents of the period. Mr. Buhrman. *Prereq.*: Fr. 6. 3 lec.; 3 cr.

61-62. ADVANCED FRENCH GRAMMAR AND COMPOSITION. A systematic study of French grammar with much oral and written practice. For students who wish to perfect their command of written and spoken French, with a view to teaching, traveling, or further advanced study. Conducted largely in French. *Prereq.*: French 14 or the equivalent. 3 rec.; 3 cr.

72. FRANCE TODAY. A course designed to bring the student up to date on the realities of modern French civilization. It covers the most significant aspects and trends of literary, artistic, social, economic, and political life in France today. Lectures and discussions conducted in French. Mr. Faulkner. *Prereq.*: French 14 or the consent of the instructor. 3 lec.; 3 cr. (Not offered in 1960-61.)

101, 102. HISTORY OF FRENCH LITERATURE. This course is not an introduction to French literature, but complements what the student has previously learned. In general, each student is expected to study more carefully the authors of whom he has some knowledge, to fill in the gaps between courses he has taken, and to obtain an integrated knowledge of all French literature. Mr. Faulkner, Mr. Buhrman. *Prereq.*: Permission of Chairman of Department. 3 cr.

103, 104, 105, 106. SPECIAL STUDIES IN FRENCH LANGUAGE AND LITERATURE. Individual guided study in special topics, with training in bibliography, note taking, and organization of material. Examples of topics which may be selected by instructor and student in conferences are: (a) the work of Jean Jacques Rousseau; (b) the theater in the eighteenth century; (c) the work of Victor Hugo; (d) French-Canadian literature; (e) phonetic symbols — theory and practice. Mr. Faulkner, Mr. Buhrman. *Prereq.*: Permission of Chairman of Department. 3 cr.

151-152. FRENCH LITERATURE OF THE MIDDLE AGES AND THE RENAISSANCE. 3 rec.; 3 cr.

153-154. FRENCH LITERATURE OF THE SEVENTEENTH AND EIGHTEENTH CENTURIES. 3 rec.; 3 cr. *Prereq.*: Introduction to French Literature or the equivalent.

155-156. FRENCH LITERATURE OF THE NINETEENTH AND TWENTIETH CENTURIES. 3 rec.; 3 cr.

German

53-54. GERMAN LITERATURE OF THE EIGHTEENTH CENTURY. German literature from the beginning of the century to the advent of Romanticism. Topics studied include: the rise and development of Classicism, the masterpieces of Lessing, Goethe, and Schiller, the decline and disintegration of Classicism in the 18th century. Collateral readings. *Prereq.*: German Civilization and Literature. 3 rec.; 3 cr. (Not offered in 1960-61.)

55-56. GERMAN LITERATURE OF THE NINETEENTH CENTURY. The period from 1800 to the death of Nietzsche will be viewed in four aspects: (a) rise and development of the Romantic School, including the Romantic Opera; (b) history of the drama as reflected in the works of Kleist, Grillparzer, Hebbel, Hauptmann; (c) the novel as illustration of social and cultural conditions with emphasis on the humorists (Richter, Grabbe, Meyer, Keller, Busch); (d) the collapse of the idealistic systems of philosophy as reflected in the works of Schopenhauer and Nietzsche and others. Mr. Lepke. *Prereq.*: German Civilization and Literature. 3 rec.; 3 cr. (Not offered in 1960-61.)

57-58. GERMAN LITERATURE FROM 1900 TO THE PRESENT. Including the schools of Naturalism, Impressionism, Expressionism, and "Neue Sachlichkeit". Emphasis is placed on the works of Kafka and of the Nobel-prize winners, Hauptmann, Spitteler, Thomas Mann, and Hesse. Readings and discussions will be supplemented by articles and commentaries from current German literary magazines. Mr. Lepke. *Prereq.*: Intermediate German. 3 rec.; 3 cr. (Not offered in 1960-61.)

103, 104, 105, 106. SPECIAL STUDIES IN GERMAN LITERATURE. Individual guided study in special topics, with training in bibliography, note taking, and organization of material. Examples of topics which may be selected by instructor and student in conference are: (a) Middle High German; (b) the Renaissance; (c) Goethe; (d) German Romanticism; (e) 20th century German literature. Mr. Danoff, Mr. Lepke. *Prereq.*: Permission of Chairman of Department. 3 cr. (Offered in 1960-61.)

153-154. GERMAN LITERATURE OF THE EIGHTEENTH CENTURY. 3 rec.; 3 cr. *Prereq.*: German Civilization and Literature. (Not offered in 1960-61.)

155-156. GERMAN LITERATURE OF THE NINETEENTH CENTURY. 3 rec.; 3 cr. Mr. Lepke. *Prereq.*: German Civilization and Literature. (Not offered in 1960-61.)

157-158. GERMAN LITERATURE FROM 1900 TO THE PRESENT. 3 rec.; 3 cr. Mr. Lepke. *Prereq.*: Intermediate German. (Not offered in 1960-61.)

Latin

53-54. THE HISTORIANS. Livy, Suetonius, and Tacitus will be studied in selected works. Illustrated lectures and outside readings will serve to provide the historical, social, and political background of Rome. Mr. Walsh. *Prereq.*: Latin Prose and Poetry or the equivalent. 3 rec.; 3 cr. (Offered in 1960-61.)

55-56. LITERATURE AND HISTORY. A comprehensive view of Latin Literature of the Golden Age, particularly the works of Caesar, Cicero, and Virgil. Literary value and historical content will be studied as well as such background of the history of Rome during the period as is necessary for the

student or teacher of the classics. Mr. Walsh. *Prereq.*: Latin Prose and Poetry or the equivalent. 3 rec.; 3 cr. (Not offered in 1960-61.)

LATIN-EDUCATION (LAT-ED) 91-92. PROBLEMS IN THE TEACHING OF HIGH-SCHOOL LATIN. The study of methods, objectives, and problems of teaching high-school Latin will be carried on throughout the year concurrently with work in composition and conversation. *Prereq.*: Permission of the instructor. 3 rec.; 3 cr. (Not offered in 1960-61.)

103, 104, 105, 106. **SPECIAL STUDIES IN LATIN LITERATURE.** Individual guided studies in special topics, with training in bibliography, note taking, and organization of material. Examples of topics which may be selected by instructor and student in conference are: (a) Virgil; (b) Tacitus; (c) Lucretius; (d) Horace. Mr. Walsh. *Prereq.*: Permission of Chairman of Department. 3 cr.

153-154. **THE HISTORIANS.** Mr. Walsh. 3 rec.; 3 cr. *Prereq.*: Latin Prose and Poetry or the equivalent. (Offered in 1960-61.)

155-156. **LITERATURE AND HISTORY.** Mr. Walsh. 3 rec.; 3 cr. *Prereq.*: Latin Prose and Poetry or the equivalent. (Not offered in 1960-61.)

Spanish

51. **SPANISH LITERATURE UP TO 1600 AND CERVANTES.** Readings and discussion of the general human creations of early Spanish Literature such as *El Poema de Mio Cid*, *El Libro de Buen Amor*, *La Celestina* and *Don Quijote*, and their social and historical background. The first part of the course will cover early Spanish literature up to Cervantes. The second part of the course will be devoted entirely to Cervantes: his life, drama, *Novelas Ejemplares*, and his masterpiece *Don Quijote*. Mr. Cryesky. *Prereq.*: Spanish 6 or equivalent. 3 lec.; 3 cr. (Offered in 1960-61.)

52. **DRAMA AND POETRY OF THE SIGLO DE ORO.** Discussion of the social background of the baroque period and readings of the representative plays of Lope de Vega, Calderon, Alarcon, Tirso de Molina, and the poetry of Gongora and Quevedo. Development of the prose of the period. Mr. Leighton. *Prereq.*: Spanish 6 or equivalent. 3 rec.; 3 cr. (Offered in 1960-61.)

55. **LITERATURE OF THE NINETEENTH CENTURY.** After a preliminary survey of the Eighteenth Century this course will cover the readings and discussion of the main literary movements and writers of the Nineteenth Century such as: Quintana, Espronceda, Zorrilla, Larra, Duque de Rivas, Becquer, Perez Galdos, Valera, Pereda, Clarin, and Echegaray. Social and historical background of Spain in relation to Nineteenth Century thought in Europe. Mr. Casas. *Prereq.*: Spanish 6 or equivalent. 3 rec.; 3 cr. (Not offered in 1960-61.)

56. **CONTEMPORARY SPANISH LITERATURE.** Starting with the Generation of '98, this course will cover the readings and discussion of the works of such writers as Unamuno, Azorin, Baroja, Machado, J. R. Jimenez, Ortega y Gasset, Garcia Lorca, Perez de Ayala, Casona, Benavente, and a survey of Spanish literature and thought since 1939. Mr. Casas. *Prereq.*: Spanish 6 or equivalent. 3 rec.; 3 cr. (Not offered in 1960-61.)

65, 66. **SPANISH AMERICAN LITERATURE.** Lectures and discussion on the main themes of Spanish American literature through the readings of the

works of the most representative authors along with a historical, social and geographical background of the New World. Mr. Casas. *Prereq.*: Spanish 6 or equivalent. 3 rec.; 3 cr. (Not offered in 1960-61.)

103, 104, 105, 106. SPECIAL STUDIES IN SPANISH LANGUAGE AND LITERATURE. Individual guided study in special topics, with training in bibliography, note taking, and organization of material. Examples of topics that may be selected by instructor and student in conference are: (a) 18th, 19th, or 20th century literature in Spain; (b) literature and civilization in Spain in the Golden Age; (c) the literature of individual Latin-American countries; (d) literary relations of Europe and Latin-America. Mr. Casas, Mr. Cryesky, and Mr. Leighton. *Prereq.*: Permission of Chairman of the Department. 3 cr.

151. SPANISH LITERATURE UP TO 1600 AND CERVANTES. Mr. Cryesky. *Prereq.*: Spanish 6 or equivalent. 3 lec.; 3 cr. (Offered in 1960-61.)

152. DRAMA AND POETRY OF THE SIGLO DE ORO. Mr. Leighton. *Prereq.*: Spanish 6 or equivalent. 3 rec.; 3 cr. (Offered in 1960-61.)

155. LITERATURE OF THE NINETEENTH CENTURY. Mr. Casas. *Prereq.*: Spanish 6 or equivalent. 3 rec.; 3 cr. (Not offered in 1960-61.)

156. CONTEMPORARY SPANISH LITERATURE. Mr. Casas. *Prereq.*: Spanish 6 or equivalent. 3 rec.; 3 cr. (Not offered in 1960-61.)

165-166. SPANISH AMERICAN LITERATURE. Mr. Casas. *Prereq.*: Spanish 6 or equivalent. 3 rec.; 3 cr. (Not offered in 1960-61.)

MATHEMATICS

M. EVANS MUNROE, *Chairman*

The Mathematics Department offers courses leading to two graduate degrees: Master of Science and Master of Science for Teachers.

To be admitted to graduate study for the M.S. degree in Mathematics, a candidate must have satisfactorily completed Mathematics 61-62 (Higher Algebra), Mathematics 67-68 (Real Analysis), or the equivalent of one of these sequences elsewhere. Students planning to do graduate work in mathematics are strongly advised to complete both these sequences as undergraduates. A candidate for the degree of Master of Science in Mathematics who presents only the minimum number (18) of credits in courses numbered 100-149 will be required to present a total of 34 credits for the degree.

Graduate study leading to the M.S. degree in Mathematics is intended to provide a broad and sound training in the fundamentals. The student will, in general, be expected to include in his program courses in analysis, algebra, and geometry. An oral examination will be required of all candidates for the M.S. degree.

To be admitted to graduate study for the M.S.T. degree in Mathematics a candidate must have satisfactorily completed the requirements for secondary school teacher certification in Mathematics. Courses leading to this degree will normally be chosen from those numbered 150-199. Secondary school teachers interested in this degree should consult the Chairman of the Department.

51. METHODS OF APPLIED MATHEMATICS I. Solutions of ordinary differential equations by D-operators, Laplace Transforms, and by series; representation of functions by definite integrals (Gamma, Beta, and error functions); Bessel functions; Fourier Series. *Prereq.*: Math. 15 or 24. 3 rec.; 3 cr.

52. METHODS OF APPLIED MATHEMATICS II. Vector analysis (line, surface, and volume integrals); elementary variational techniques; development of some partial differential equations of mathematical physics; solutions of partial differential equations by Laplace transforms and by Green's functions. *Prereq.*: Math. 51 or 58. 3 rec.; 3 cr.

54. NUMERICAL METHODS. Formal introduction to computation formulas for elementary functions which have been programmed for digital computers and to elementary differentiation and integration formulas; simple numerical techniques for solving ordinary and partial differential equations; matrix analysis; numerical solutions of linear systems and discrete eigenvalue problems; solutions of algebraic equations; smoothing techniques. *Prereq.*: Math. 15 or 24. 3 rec.; 4 cr.

55. FUNDAMENTAL CONCEPTS OF GEOMETRY. Systems of postulates of various geometries; geometric invariants; synthetic and analytic projective geometry; introduction to non-Euclidean geometry, topology, and the elementary differential geometry of curves and surfaces. *Prereq.*: Math. 15 or 23. (Math. 15 may be taken concurrently). 4 rec.; 4 cr.

56. TOPICS IN NUMBER THEORY. Elementary properties of integers; the Euclidean algorithm; divisibility; diophantine equations of the first degree; congruences; residue classes and the Euler function; distribution of primes; quadratic residues; diophantine equations of the second degree; selected topics in diophantine approximation and number-theoretic functions. *Prereq.*: Math. 10 or 23. 3 rec.; 4 cr.

58. FOURIER SERIES AND BOUNDARY VALUE PROBLEMS. Series solution of differential equations; the Hypergeometric equation; representation of functions by orthogonal series and, in particular, by trigonometrical series; application of the theory of Laplace and Fourier transforms to the solution of boundary value problems; the partial differential equations of mathematical physics. *Prereq.*: Math. 15 or 24. 4 rec.; 4 cr.

61-62. HIGHER ALGEBRA I, II. The integers, the rational, real and complex number systems, congruences, theory of polynomial equations, theory of groups, vector spaces and transformations, matrices and determinants, rings, integral domains, fields, ideal theory, lattices, and Boolean algebras. *Prereq.*: Math. 10 or 23. 4 rec.; 4 cr.

65-66. ADVANCED CALCULUS. Functions of several variables, continuity, limits, partial differentiation; multiple, line and surface integrals; uniform convergence, improper integrals; Gamma and Beta functions; Fourier series and integral; Stieltjes integral; Laplace transform. *Prereq.*: Differential Equations. 3 rec.; 3 cr. (Will not be offered after 1960-61.)

67. REAL ANALYSIS I. The real number system; elements of set theory; theory of limits; continuous functions and their properties; differentiability and the mean value theorem. *Prereq.*: Math. 10 or 23. 4 rec.; 4 cr.

68. REAL ANALYSIS II. The Riemann integral; uniform convergence; double and iterated limits; applications of double limit theorem to series, limits under the integral sign, and existence theorems for differential equations. *Prereq.*: Math. 67. 4 rec.; 4 cr.

81. THEORY OF APPROXIMATION. The theorems of Weierstrass on approximation of continuous functions; the Tschebycheff approximation problem; Tschebycheff polynomials; trigonometric polynomials of best approximation; interpolation; the formulas of Lagrange and Newton, trigonometric interpolation. *Prereq.*: Math. 15 or 24. 3 rec.; 4 cr.

82. NON-LINEAR DIFFERENTIAL EQUATIONS. Phase plane analysis of linear systems and non-linear conservative systems; stability theorems; limit cycles and periodic solutions; the Van der Pol equation; the method of Kryloff and Bogolionboff. *Prereq.*: Math 15 or 24. 3 rec.; 4 cr.

83. INTRODUCTION TO DIFFERENTIAL GEOMETRY. A first course in the metric differential geometry of curves and surfaces in Euclidean space. *Prereq.*: Math. 15 or 24. 3 rec.; 4 cr.

84. INTRODUCTION TO TOPOLOGY. Elementary point-set topology in metric and topological spaces, in particular the real line and plane. *Prereq.*: Math. 68. 4 rec.; 4 cr.

85-86. THEORY OF FUNCTIONS. An introductory course in the theory of both functions of a real variable and functions of a complex variable. Topics covered will include the real and complex numbers, elements of point set theory, various classes of functions and their properties, Riemann integral, analytic functions, Cauchy theorem, infinite series, residues, contour integration, existence theorems in differential equations. *Prereq.*: Applied Mathematics. 3 rec.; 3 cr. (Will not be offered after 1960-61).

88. COMPLEX ANALYSIS. The complex number system; analyticity; elementary functions; Cauchy integral theorem and formulas; Taylor and Laurent series; singularities and residues; conformal mapping. *Prereq.*: Math. 15 or 24. 4 rec.; 4 cr.

91. MATHEMATICS-EDUCATION (MATH-Ed). The aims and values of secondary-school mathematics; the recommendations of the national committee on mathematics requirements, and the State Board requirements; the subject matter and the sequence in which it should be presented in both junior and senior high schools; techniques and instructional aids used in teaching secondary-school mathematics; errors, testing program, remedial teaching. Students preparing to teach mathematics in high school should register for this course — it is a prerequisite for Supervised Teaching in Mathematics. Lectures, assigned readings, and discussions. *Prereq.*: Education 58 and Mathematics 10 or 22. 3 rec.; 3 cr. May be counted as major credit only by students preparing to teach mathematics in the secondary schools.

96. INTRODUCTION TO THEORY OF DIFFERENTIAL EQUATIONS. Existence and uniqueness theorems for ordinary differential equations; theory of linear ordinary differential equations of order n ; oscillation and comparison theorems for second order linear ordinary differential equations; first order partial differential equations, linear partial differential equations of the second order. *Prereq.*: Math. 68. 3 rec.; 4 cr.

101-102. FUNCTIONS OF A COMPLEX VARIABLE. Complex numbers, infinite series, analytic functions, Cauchy theorem and its generalizations, contour integrals, meromorphic and entire functions, conformal mapping, analytic continuation, Riemann surfaces. Selected topics from among the following: differential equations, special functions, potential theory, Laplace transforms. *Prereq.*: Advanced Calculus or equivalent. 3 rec.; 3 cr.

103-104. THEORY OF FUNCTIONS OF REAL VARIABLES. The real number system; theory of point sets; fundamental theorems on continuous functions, differentiation, integration, implicit functions; measure, Lebesgue integral and applications; generalized integration, different types of generalized convergence; introduction to modern functional analysis. *Prereq.*: Advanced Calculus or equivalent. 3 rec.; 3 cr.

105-106. DIFFERENTIAL GEOMETRY. The application of the calculus to the metric differential theory of curves and surfaces in Euclidean space; tensor analysis, Riemannian geometry, applications, such as the theory of relativity. *Prereq.*: Advanced Calculus or equivalent. 3 rec.; 3 cr.

107-108. MODERN ALGEBRA. Abstract algebra, including theory of rings and ideals; fields and their transcendental and algebraic extensions, valuation theory; Galois theory; algebraic numbers. *Prereq.*: Higher Algebra. 3 rec.; 3 cr.

113-114. MATHEMATICAL STATISTICS. Essentially a mathematical course in the theory of statistics. *Prereq.*: Permission of the instructor. 3 rec.; 3 cr.

117-118. TOPOLOGY. Review of elementary theory of abelian groups and vector spaces. Metric spaces and elements of point set topology. Elementary homology theory of complexes, homology groups, Betti numbers, torsion coefficients. Fixed point and duality theorems. Applications to integration, differential equations. Riemann surfaces, Jordan curve theorem and its generalizations. *Prereq.*: Higher Algebra. 3 rec.; 3 cr.

121-122. ADVANCED APPLIED MATHEMATICS. Tractable mathematical problems arising out of the analytical formulation of physical problems in various branches of the applied sciences (elasticity, hydrodynamics physics, etc.) will be studied by traditional means such as transform methods (Fourier, Laplace, etc.), series methods (Fourier, Bessel, Legendre) including Sturm-Liouville theory, integro-differential methods, and numerical approximations. In addition, some more modern techniques will be introduced as time and interest permit. *Prereq.*: Consent of the instructor. 3 rec.; 3 cr.

125-126. NUMERICAL ANALYSIS. Numerical processes which are especially useful in connection with digital computers will be studied. Among these are numerical methods for treating determinants and matrices of large order, for solving non-linear equations, and for solving ordinary and partial differential equations. Also included will be polynomial approximations and differencing techniques leading to differentiation and integration formulas, least squares approximations, curve fitting by means of orthogonal polynomials, and Gaussian quadrature formulas. Error control will be investigated in connection with these processes. Some numerical problems which result from traditional applied mathematical techniques will be analyzed. *Prereq.*: Differential Equations or equivalent. 3 rec.; 3 cr.

127-128. THEORY OF ORDINARY DIFFERENTIAL EQUATIONS. Existence and uniqueness theorems for a single equation and for systems of equations; the linear equation of order n ; linear systems; Sturm-Liouville theory; singular-

ities of autonomous systems; Poincare-Bendixson theory; non-linear differential equations; applications to vibration theory. *Prereq.*: Advanced Calculus or equivalent. 3 rec.; 3 cr.

131. ALGEBRAIC NUMBER THEORY. Elementary number theory, group theory, arithmetic of algebraic number fields, Dirichlet's theorem on the group of units, finiteness of class number, ramification theory, Fermat's theorem for regular primes. *Prereq.*: Higher Algebra (Math. 61-62, or equivalent). 3 rec.; 3 cr.

132. ANALYTIC NUMBER THEORY. Dirichlet series, Abelian and Tauberian theorems, equidistribution of primes in arithmetical progression, special topics. *Prereq.*: Theory of Functions (Math. 85-86, or equivalent). 3 rec.; 3 cr.

141-142. ADVANCED ANALYSIS. A selection of topics in advanced analysis to meet the needs of second-year graduate students. Content of the course may vary from year to year. *Prereq.*: Either Functions of a Complex Variable or Theory of Functions of Real Variables. 6 cr.

NOTE: The following courses are for candidates for the degree of Master of Science for Teachers. Ordinarily they are given either in the Summer Session or as seminars meeting on Saturday mornings.

171-172. FUNDAMENTAL CONCEPTS OF MATHEMATICS FOR TEACHERS. An introduction to the most fundamental concepts of analysis, geometry, and algebra. Basic elements of set theory; a survey of the real and complex number systems; the integers and the concept of an integral domain; introduction to groups; geometries, Euclidean and non-Euclidean; functions, sequences, and the limit concept; the derivative and the differentiation of algebraic functions. *Prereq.*: Permission of the Department Chairman. 3 cr.

173-174. HIGHER ALGEBRA FOR TEACHERS. The integers, integral domains, and topics from number theory; equivalence relations and congruences; real numbers, complex numbers, and fields; polynomials; group theory; elements of matrix theory; vectors and vector spaces; rings; Boolean algebra. *Prereq.*: Permission of the Department Chairman. 3 cr.

175-176. HIGHER GEOMETRY FOR TEACHERS. Systems of postulates of various geometries; geometric invariants; synthetic and analytic projective geometry; an introduction to non-Euclidean geometry and topology. *Prereq.*: Permission of the Department Chairman. 3 cr.

177-178. HIGHER ANALYSIS FOR TEACHERS. The real number system; variables, functions, and limits; elements of set theory; numerical sequences and series; continuity; the derivative and the Riemann integral; maxima and minima. *Prereq.*: Permission of the Department Chairman. 3 cr.

192. FUNDAMENTAL CONCEPTS IN THE HIGH SCHOOL CURRICULUM. The relation of basic notions of modern pure mathematics to the material actually taught in the high schools. *Prereq.*: Permission of the Department Chairman. 3 cr.

193. MODERN UNDERGRADUATE MATHEMATICS AND THE HIGH SCHOOL PROGRAM. Selected readings in several of the new college freshman texts as a study of the background now expected of a college freshman. *Prereq.*: Permission of the Department Chairman. 3 cr.

194. TRENDS AND DEVELOPMENTS IN HIGH SCHOOL MATHEMATICS. A detailed study of some of the revised high school curricula now in operation. *Prereq.*: Permission of the Department Chairman. 3 cr.

MECHANICAL ENGINEERING

EDWARD T. DONOVAN, *Chairman*

To be admitted to graduate study in Mechanical Engineering a student should have completed work equivalent to that required for a Bachelor of Science degree in this field, at the University of New Hampshire, and should have maintained an average grade of B for his undergraduate course. An oral examination will be required of all candidates for the Master's degree.

55-56. INTERNAL COMBUSTION ENGINES. The internal combustion engine, including its thermodynamics, carburetion, lubrication, and vibration. Also a consideration of the fundamental principles of the gas turbine and the jet engine. Mr. Stolworthy. *Prereq.*: Strength of Materials and Engineering Thermodynamics. 2 rec.; 1 lab.; 3 cr.

65. ENGINEERING ECONOMY. The principles which form the basis of engineering procedures for obtaining the highest ratio of utility to cost. 3 rec.; 3 cr.

101, 102. ADVANCED THERMODYNAMICS. The general equations of thermodynamics and their application to fluids such as air and steam; heat transmission; current applications and advances in thermodynamics. Mr. Donovan, Mr. Stolworthy, or Mr. Valentine, 3 rec.; 3 cr.

105. STRENGTH OF MATERIALS. Strain energy methods, curved bars, beams on elastic foundations, special problems in the bending of beams, thin plates and shells, thick walled cylinders, torsion, membrane analogy, deformations beyond elastic limit, and properties of materials. Mr. Kauppinen. *Prereq.*: Elementary Mechanics, Strength of Materials, and Differential Equations. 3 lec.; 3 cr.

106. THEORY OF ELASTICITY. This course covers the mathematical theory of elasticity. Plane stress and strain, two dimensional problems in rectangular and polar coordinates, strain energy methods, solution of two-dimensional problems by means of the complex variable, elementary problems in three dimensions, torsion, bending of prismatic bars and axially symmetrical stress distribution problems are treated. Mr. Kauppinen. *Prereq.*: Advanced Strength of Material. 3 lec.; 3 cr.

107. VIBRATIONS. Linear and non-linear systems; undamped, damped and forced damped systems; electro-mechanical systems and analogies; tabular methods. Mr. Kauppinen. *Prereq.*: Elementary Mechanics, Strength of Materials, and Differential Equations. 3 lec.; 3 cr.

THESIS. To be arranged. 6-8 cr.

PHYSICS

HARRY H. HALL, Chairman

For admission to graduate study in Physics the candidate must have satisfactorily completed undergraduate courses in Physics totaling 24 to 30 semester hours. Suitable undergraduate work in mathematics is essential and must include courses in differential equations and advanced calculus. The general aim of the program will be to give the student broad general training in fundamentals. To accomplish this, some intermediate courses may be required. Entering students will be expected to demonstrate proficiency in undergraduate work equivalent to that of the senior year in Physics at the University of New Hampshire. All graduate students must register for Physics 153-154.

Candidates for the Master's degree must complete a thesis for 6 hours credit, and pass an oral examination on the thesis.

The department requires one additional copy of the thesis.

81. **PHYSICAL OPTICS.** A course which starts with Maxwell's Equations and covers the nature of light; interference; diffraction; polarization, and related phenomena. *Prereq.:* Phys. 33-34, Math. 19 or 24. 3 rec.; 3 cr.

82. **THERMODYNAMICS.** Temperature, work, first and second laws, ideal gases, reversibility and irreversibility, Carnot cycle, entropy, properties of pure substances, thermodynamic applications to pure substances, introduction to the principles of statistical mechanics. *Prereq.:* Phys. 21-22 or 23-24, Math. 19, 20 or 51-52 passed or taken concurrently. 3 rec.; 3 cr.

91. **ATOMIC PHYSICS.** Elementary particles, restricted relativity, origin of the quantum theory, atomic structure, introductory wave mechanics, atomic and molecular spectra. *Prereq.:* Phys. 33-34. 3 rec.; 4 cr.

92. **NUCLEAR PHYSICS.** Natural radioactivity, nuclear reactions, nuclear scattering, models of the nucleus, high energy nuclear physics, cosmic rays. *Prereq.:* Phys. 91. 3 rec.; 4 cr.

93. **INTRODUCTION TO THEORETICAL PHYSICS I. (Electromagnetic Theory).** A review of electrostatics and magnetostatics followed by an introduction to the application of Maxwell's Equations to such topics as the propagation of plane waves, the study of wave guides and resonant cavities, and the theory of scattering, radiation from dipoles, atoms and molecules, the electron theory of dielectrics, and the electromagnetic theory of light. *Prereq.:* Math. 19, 20 or 51-52, and Phys. 33-34 or equivalent. 4 rec.; 5 cr.

94. **INTRODUCTION TO THEORETICAL PHYSICS II (Mechanics).** The subject matter will depend upon the background of the class and will include such topics as mechanics of particles, planetary motion, rigid bodies, an introduction to advanced dynamics, theory of vibrations (particles, strings, and membranes), elasticity, hydrodynamics, sound and kinetic theory. *Prereq.:* Math. 19-20 or 51-52, and Phys. 31-32 or its equivalent. 4 rec.; 5 cr.

95-96. **EXPERIMENTAL PHYSICS III-IV.** Work of research type. Special problems are assigned to the individual student. *Prereq.:* Senior standing in Physics. 2 lab.; 2 cr.

97-98. **PHYSICAL COLLOQUIUM.** Participation in departmental colloquium, reading and study. *Prereq.:* Senior standing in Physics. 1 cr.

99. **SPECIAL TOPICS.** A course designed to cover any selected topics not sufficiently well covered in a general course. *Prereq.:* Math 19-20 or 51-52, passed or taken concurrently. *Prereq.* Senior standing in Physics. 1, 2 or 3 cr.

101-102. **MATHEMATICAL PHYSICS.** Differential equations of physics, complex variables, orthogonal functions, variational methods, matrices, vector, and tensor analysis. 3 cr.

103-104. **EXPERIMENTAL PHYSICS.** Introduction to modern experimental research techniques, including discussion and laboratory exercises in fundamental measurements in optics, electromagnetism, nuclear, atomic, and molecular phenomena. 3 cr.

105. **THERMODYNAMICS.** A theoretical course in classical thermodynamics. 3 cr. (Alternate years; not offered in 1960-61.)

106. **STATISTICAL MECHANICS.** Basic principles and general methods of statistical mechanics with application to physical problems. 3 cr. (Alternate years; not offered in 1960-61.)

111. **THEORETICAL MECHANICS.** Particle mechanics, including the motion of rigid bodies, elasticity, fluid dynamics, and special relativity. Particular emphasis is given to topics in classical mechanics that serve as background for the study of modern physical theories. 3 cr.

115-116. **ELECTROMAGNETIC THEORY.** A course in classical electricity and magnetism, covering Maxwell's equations and the following topics relevant to electromagnetic fields; potentials; boundary value problems; energy; force and momentum; waves and radiation. 3 cr.

117-118. **QUANTUM MECHANICS.** An introductory course covering the physical concepts and mathematical principles underlying the formulation of Quantum Mechanics. 3 cr. (Alternate years; offered in 1960-61.)

119. **NUCLEAR PHYSICS.** An introductory course correlating experimental results with current theory, including description of properties of the nuclei, nuclear transformations, and nuclear models. 3 cr. (Alternate years; offered in 1960-61.)

125. **INTRODUCTION TO SOLID STATE PHYSICS.** Classification of solid types, Bloch functions, Brillouin Zones, crystal momentum, band approximation, electrons and holes in electric and magnetic fields, conductivity, and Hall effect in semi-conductors, rectifiers, and transistors. 3 cr.

149-150. **SPECIAL TOPICS.** Any special fields of study not covered by the above graduate courses may be included in this course. Choice of topic to be determined by class. 1, 2, or 3 cr. May be taken more than once.

151-152. **INVESTIGATION AND RESEARCH.** Theoretical or experimental investigation of a problem in Physics. 3 cr.

153-154. **SEMINAR.** Required of all graduate students. Topics to be selected. No credit.

THESIS. 6 cr.

POULTRY SCIENCE

W. C. SKOGLUND, *Chairman*

To be admitted to graduate study in Poultry Science an applicant is expected to have had sufficient undergraduate training in basic sciences to qualify for special work in this field. A thesis is required and a candidate for the Master's degree shall pass an oral examination covering his graduate courses and thesis.

51-52. **POULTRY DISEASES.** The first semester will emphasize the fundamentals of disease control. Physiology and anatomy will be briefly covered as background for the study of bacterial, fungus, and parasitic diseases of chickens. The second semester will cover basic principles of virology with application to the prevention and control of avian virus diseases. Mr. Corbett, Mr. Dunlop and Mr. Strout. 2 lec.; 1 lab.; 3 cr. (Alternate years; not offered 1960-61.)

53, 54. **POULTRY PROBLEMS.** Students are given a selection of various problems and are required to compile and present accurate and detailed information in their solution. Staff. 1 to 3 cr.

101, 102. **ADVANCED POULTRY DISEASES.** A study of the causes and effects of disease applied to the body as a whole. Lectures supplemented by laboratory demonstrations of the basic pathology of diseased tissue. A detailed discussion of diagnosis, prevention, control, and treatment of poultry diseases. Mr. Dunlop, Mr. Corbett, Mr. Strout. *Prereq.:* Poultry Diseases, General Bacteriology, Histology or their equivalent. 3 cr.

103, 104. **ADVANCED POULTRY NUTRITION.** A comprehensive study of metabolism and the physiology of digestion with special emphasis on nutrient needs and deficiency diseases of poultry. Mr. Ringrose. 3 lec.; 3 cr.

105, 106. **SEMINAR.** A survey of recent literature and research in Poultry Science. Mr. Skoglund. 1 cr. per semester.

107, 108. **SPECIAL PROBLEMS.** The student with the instructor selects a problem. He is then required to outline, organize, and conduct the necessary research, accurately gather and evaluate the pertinent data, and present the results of the study in a written report. Staff. Hours and credits not to exceed 3 each semester are to be arranged.

109, 110. **THESIS.** Hours and credits, from 6 to 10. are to be arranged.

111, 112. **AVIAN HISTOPATHOLOGY.** The first semester consists of a course in general histopathology. The second semester will include a discussion of special histopathology and its relationship to diagnosis and the control of poultry diseases. Mr. Dunlop. *Prereq.:* Poultry Science 101, 102, Histology, and permission of the instructor. 3 cr.

113, 114. **ADVANCED POULTRY BREEDING.** A study of the anatomy and physiology of the fowl; inheritance of morphological and color characteristics; application of principles of population genetics to poultry breeding. Mr. Collins. 3 lec.; 3 cr.

PSYCHOLOGY

HERBERT A. CARROLL, *Chairman*

In addition to meeting the requirements for entrance into the Graduate School, students admitted to graduate study in Psychology must have had a minimum of 15 credits in undergraduate courses in Psychology. It is desirable that these credits include a course in elementary statistics.

Each graduate student is urged to include some individual work in his program. This can be done by registering for Psychology 172, Graduate Internship; Psychology 181, 182, Reading and Research in Psychology; or Thesis.

A comprehensive written examination is required of all candidates for the Master's degree. An oral examination on the thesis is required of all those who write a thesis. An oral examination may be required of those who do not write a thesis.

Candidates for the Master's degree in Psychology can specialize in one of four areas: Industrial and Personnel, Institutional and Clinical work, School Counseling, and General Psychology. The courses to be taken in each field of specialization will be selected by the student and his supervisor on the basis of his needs, interests, and courses taken earlier. Departments such as Education, Sociology, and Economics will be drawn upon for related course material.

The department has two objectives in its graduate curriculum: the preparation of students for advanced study beyond the Master of Arts in all fields of psychology and for professional work in the applied areas at the Master's level.

54. **PSYCHOPATHOLOGY.** A systematic examination is made of the more severe behavioral disorders as found in the major forms of the neuroses and psychoses. The ego defense mechanisms and the construct of anxiety are seen as central to the understanding of these disorders. The search for causes, the interpretation of symptoms, and the methods of treatment are considered in detail. Mr. Berger. *Prereq.*: Psychology 47. 3 lec.; 3 cr.

57. **EXPERIMENTAL PSYCHOLOGY.** A study of experimental methods in psychology including discussion of theory and practices in applying these methods to a variety of psychological phenomena. Each student in the class will be responsible for an individual experimental project. Mr. Haslerud. *Prereq.*: Psychology 1. 1 lec.; 1 lab.; 3 cr.

58. **PSYCHOLOGY OF LEARNING.** A study of the experimental support for and the practical implications of contemporary theories of learning. Mr. Haslerud. *Prereq.*: Psychology 1. 3 lec.; 3 cr.

63. **DIFFERENTIAL PSYCHOLOGY.** A study of individual differences with special attention being given to those who are intellectually gifted or mentally retarded. Mr. Berger. *Prereq.*: Psychology 1. 3 lec.; 3 cr.

67. **STATISTICS IN PSYCHOLOGY.** A study of the problems and methods involved in the statistical treatment of quantitative data in psychology. Both the computation and interpretation of elementary statistical measures, such as mean, median, standard deviation, test or critical ratio, and the various methods of correlation are considered in detail. Mr. Roen. *Prereq.:* Psychology 1. 3 lec.; 3 cr.

78. **PHYSIOLOGICAL PSYCHOLOGY.** A study of the relation between behavior and the structure of the organism. Special attention to the sensory, nervous, and glandular functions as the organic base for motivation, emotion, learning, etc. Mr. Haslerud. *Prereq.:* Psychology 1. 3 lec.; 3 cr.

83. **SYSTEMATIC PSYCHOLOGY.** The complex expansion of contemporary psychology as seen in historical perspective. A consideration of some of the major antecedents in philosophy, theology, and the physical sciences. Emphasis is placed on the subsequent extensive development of psychology in the United States in the form of complementary schools and systems of thought and research. Mr. Berger. *Prereq.:* Psychology 1. 3 lec.; 3 cr.

84. **CONSTRUCTION OF CLASSROOM TESTS.** Underlying philosophy of testing. Use of tests for improvement of instruction, evaluation, and diagnosis. Construction principles for objective tests and especially techniques applicable to major fields. Students will be required to build tests in major teaching field. *Prereq.:* Education 61, Education 58 or equivalent in terms of actual teaching experience. Consent of the instructor. 3 cr. *Offered only as an Extension course. Register for Psychology 84-X.*

86. **PERSONNEL PSYCHOLOGY.** An intensive study of the principles involved in the selection and placement of personnel. The course is offered primarily for students intending to specialize in the personnel field. Topics covered include: counseling, interview techniques, psychological tests, and the personnel officer in industry. Some knowledge of elementary statistics is desirable. Mr. Kay. *Prereq.:* Psychology 1. 3 lec.; 3 cr.

87. **APPLIED PSYCHOLOGICAL TESTING.** The planning and execution of testing programs in the institutional setting. Special emphasis upon practical problems of administration and preparation or normative and validating data. The conference-laboratory method will be emphasized. Students will be required to complete a project that will bear definite relationship to the local institutional program. Open only to practicing teachers, counselors, guidance and personnel workers. Class enrollment limited to 20 students. *Prereq.:* Consent of the instructor. 3 cr. *Offered only as an Extension course. Register for Psychology 87-X.*

88. **COUNSELING TECHNIQUES FOR TEACHERS.** A study of the tools and techniques involved in counseling and guidance. Special emphasis will be placed upon understanding of the psychological principles involved in promoting the personal, educational, vocational, and social growth of young people. The student-centered approach will be emphasized. Reports and papers will be required. *Prereq.:* Consent of the instructor. 3 cr. *Offered only as an Extension course. Register for Psychology 88-X.*

89. **MENTAL HYGIENE IN TEACHING.** A study of the fundamental needs of human beings, with special emphasis on the mental and emotional conflicts of secondary-school students arising from the thwarting of these needs. Ways of recognizing these conflicts by their manifestations and of helping students to resolve them will be treated extensively in the course. Attention will also be given to the mental hazards of the teaching profession. Mr. Jervis. 3 cr. *Not open to students who have completed Psychology 47.*

95. **ADVANCED GENERAL PSYCHOLOGY.** A systematic study of current psychology to help the student, by lectures, demonstrations, and reports, to obtain a broad, integrated view of the subject as both science and art. Mr. Haslerud. *Prereq.:* 12 semester credits in Psychology. 3 lec. 3 cr. *Required of all undergraduate majors in Psychology.*

98. **SEMINAR IN PSYCHOLOGY.** An extensive term paper on subjects chosen by the individual students. This project in library research meets the department's requirement for a comprehensive paper. Mr. Carroll. *Prereq.:* 15 semester credits in Psychology. 3 cr. *Required of all undergraduate majors in Psychology.*

105-106. **CLINICAL PSYCHOLOGY.** A study of procedures in the treatment of functional behavior disorders. Directive and non-directive methods in psycho-therapy are compared and critically evaluated. Special attention is given to the client-centered approach as presented by Rogers. During the second semester attention is concentrated on actual cases. Specific techniques in psycho-therapeutic interviews are demonstrated and evaluated through the use of recorded interviews. Students are given practice in conducting interviews with fellow students. Mr. Carroll. 3 cr. each semester.

108. **CASE STUDIES IN COUNSELING.** In this course actual cases will be used to reflect a variety of personality theories and counseling techniques. A detailed examination will be made of two individuals in the counseling processes. Other cases will be considered more briefly to explore the interaction of counselor and counselee. The aim of the course is to develop an appreciation of the complexities of human behavior, to gain increased respect for the integrity of individuals and their difficulties in revealing themselves to a counselor, and to understand better the difficulties in applying theoretical knowledge to the counseling situation. Mr. Jervis. 3 cr.

114. **STATISTICAL PROBLEMS IN PSYCHOLOGY.** Practice in the set-up of parametric and non-parametric statistical problems commonly found in the current literature of experimental, clinical, and industrial psychology. Emphasis is placed on understanding the assumptions of the various procedures. Mr. Haslerud. *Prereq.:* Psychology 67 or its equivalent. 3 cr.

123. **INDIVIDUAL TESTING.** This course is designed to train students in the administration, scoring, and interpretation of individual tests for the appraisal of intelligence. Such instruments as the Wechsler Adult Intelligence Scale, the Stanford-Binet and the Wechsler Intelligence Scale for Children will be critically analyzed. Students will be required to purchase one set of test materials. Mr. Roen. 3 cr.

131. **GRADUATE SEMINAR.** Advanced research methods. An intensive examination of the research process as the attempt to discover answers to meaningful questions through the application of scientific procedures. Attention is focused on the relation of theory to research, experimental design, problems of measurement, techniques for data collection, and interpretation of results. Mr. Kay. 3 cr.

141. **PERSONALITY DYNAMICS.** An evaluation of the major theories of personality, especially as they bear upon current research and clinical practice. Authentic case histories, recorded therapy sessions, and empirical studies within the framework of each theoretical position are used as concrete source material. Mr. Berger. 3 cr. (offered in 1960-61.)

150. **ADVANCED INDUSTRIAL PSYCHOLOGY.** A survey of the literature on applied experimental psychology; industrial relations; and personnel selection, classification, and training. Attention will be given to the aims, principles, and methods applicable to each of these three areas. Mr. Kay. *Prereq.:* Psychology 32 or its equivalent and Psychology 67 or its equivalent. 3 cr.

162. **PSYCHOLOGY OF PERCEPTION.** A study of the experiments and theories dealing with the fundamental stimulus situation in the internal and external environment. This knowledge of how the organism sees and interprets his world has many applications, e.g., social stimulation, self-regard, and a basis for the projective tests. Mr. Kay. 3 cr.

164. **INTRODUCTION TO THE RORSCHACH TEST.** This course is concerned with teaching the administration, scoring, and preliminary interpretation of the Rorschach Inkblot Test. Students will be required to purchase the test materials and to administer and score a minimum of twenty Rorschachs. Klopfer's scoring system will be used for the determinants and Beck's for location. Mr. Roen. 3 cr.

172. **GRADUATE INTERNSHIP.** Practical work experience in clinical or industrial psychology. Students will be assigned to institutions or industries and serve under experienced personnel and under supervision of departmental instructors. *Prereq.:* Open to a limited number of graduate students who secure permission of the departmental supervisor. Mr. Carroll. Credits to be arranged up to a maximum of 6.

181, 182. **READING AND RESEARCH IN PSYCHOLOGY.** A student may undertake a course of readings in psychological journals and books or work on an experiment or other research on some topic acceptable to both student and instructor. The projects are directed by individual conferences. Staff. 3 cr.

THESIS. Open to students who are especially interested in doing independent original research. 6 cr.

SOCIOLOGY

RICHARD S. DEWEY, *Chairman*

Admission to graduate status in the Department of Sociology is granted to the student who meets the entrance requirements of the Graduate School and who has completed a minimum of 12 credits in Sociology.

In addition to having fulfilled the general requirements, the successful candidate for the Master of Arts degree in Sociology will have completed a thesis written in one of the following fields: criminology, cultural anthropology, mass communications, minority group relations, population, rural sociology, social movements, social stratification, social theory, and urban sociology. It is expected that competence in both method and theory will be demon-

strated in the thesis. No more than 9 semester hours' credit in other departments will be accepted. No general oral or written examination is required.

52. **POPULATION ANALYSIS.** A seminar course in demography using as its principal materials data from the U. S. Census of Population and U. S. Vital Statistics. Growth and leveling of city and state populations; distribution of such factors as age, sex, marital status, and years of schooling; differential birth and death rates; real and apparent changes in causes of death; international and interstate migration, and theories advanced to explain geographical mobility. Training in statistics not required. 3 lec. or rec.; 3 cr.

54. **CULTURE CHANGE.** Theories of culture change are evaluated. The processes of discovery, invention, diffusion, and acculturation are illustrated by selected anthropological studies of the culture of non-literate and literate societies. *Prereq.:* Soc. 33 or its equivalent. 3 lec. or rec.; 3 cr.

57. **SOCIAL STRATIFICATION.** A study of social stratification, with most of the descriptive material relating to the social class system of the United States. Attention is focused on theories of stratification, stratification systems, class interests, class conflicts, class differentials, and social mobility. 3 lec. or rec.; 3 cr.

59. **AGING IN THE AMERICAN SOCIETY.** Social differentiation on the basis of age groups, with the aged in the contemporary American society being emphasized. Attention is focused on: attitudes and behavior toward the aged; attitudes and behavior of the aged; problems of the aged in society. Proposed programs for change in the treatment and behavior of the aged are examined. 3 lec. or rec.; 3 cr. (Alternate years.)

62. **SOCIAL MOVEMENTS.** The factors related to the origin and development of reforms, revolutionary, religious, and other social movements. Generalizations concerning the organization, structure, tactics, and leadership of social movements are described. Consideration is given to the purposes and consequences of selected movements, as well as to the relationships between social movements and social change. *Prereq.:* Soc. 1. 3 lec or rec.; 3 cr.

71. **CRIMINOLOGY.** A survey of the scientific study and the control of crime. The following are considered in detail: indexes and rates of crime; theories of crime; juvenile delinquency; police, courts, prisons, probation and parole. Case studies are presented. 3 lec. or rec.; 3 cr.

72. **THE FAMILY.** A study of the family as a social institution, with most of the descriptive material relating to the contemporary American family. Attention is focused on the variety of family forms, sex behaviour patterns, mate selection, marital adjustment, parent-child relations, family crises, and family reorganization. 3 lec. or rec.; 3 cr.

73, 74. **INTRODUCTION TO SOCIAL WELFARE.** Survey of the field of social welfare; history; public welfare; case work; social group work; community organization for social welfare. *Prereq.:* Permission of the instructor. 3 lec. or rec.; 3 cr.

75, 76. **METHODS OF SOCIAL RESEARCH.** Analysis of research problems. Designing field studies and experiments. Demonstration and practice in sampling, schedule construction, and interviewing techniques. The first semester will emphasize use of elementary statistical techniques in analysis of

prepared data. The second semester will emphasize methods of observation. For Sociology majors and students enrolled in the Social Service Curriculum; others may be admitted by permission of instructor. 3 lec. or rec.; 3 cr.

88. **CRIME CONTROL.** A seminar course which deals with the theory and practice of preventing crime and delinquency and of rehabilitating the criminal and the delinquent. There will be a number of lectures by, and discussions with, various penologists. Limited to 15 students. *Prereq.*: Sociology 71. Permission of instructor. 3 cr.

92. **FIELDS OF SOCIOLOGY.** A consideration of various subject areas of sociology indicating their growth and development, their relationship to one another, and their current status with regard to research and theory. A discussion of recent developments and the newer subject areas of sociology. Future developments, as extensions of present trends, are discussed. Students not majoring in sociology may be admitted by permission of the instructor. 3 lec. or rec.; 3 cr.

93. **MASS COMMUNICATION.** An examination of the media of mass communication (press, radio, film, and television) including: the history and present position of each of these media; their organizational structure; and the characteristics of their audiences. The educational, informational, and persuasive functions of the media are discussed and various methods for evaluating effectiveness in each of these areas are examined. *Prereq.*: Permission of the instructor. 3 lec. or rec.; 3 cr.

181, 182. **READING AND RESEARCH IN SOCIOLOGY.** With the consent of the instructor, a student prepared by training and experience to do independent work may register for a reading and research course. Under the guidance of the instructor, the student will undertake problems and readings in one or more of the following areas: Methods of Social Research (Staff); Mass Communication (Mr. Shaw); Population (Mr. Durgin); Rural Sociology (Mr. Durgin); Social Control (Mr. Palmer); Social Differentiation (Mr. Nielson); Social Theory (Mr. Bobick); Urban Sociology (Mr. Dewey); and Special Areas (Staff). Hours and credit to be arranged.

185, 186. **DEVELOPMENT OF SOCIOLOGICAL THEORY.** A consideration of the development of social thought from Plato to the present. During the first semester the works of selected individuals from Plato to Comte will be examined. Emphasis in the early part of the second semester is on the 19th century European social philosophers, with the remainder of the term centering attention upon the ideas of U. S. social scientists, especially upon their contributions to present day sociological thought. Students not majoring in Sociology may be admitted by permission of the instructor. 3 lec. or rec.; 3 cr.

THESIS. Usually 6 cr., but up to 10 cr. when the problem warrants.

ZOOLOGY

GEORGE M. MOORE, *Chairman*

To be admitted to graduate study in Zoology, students must have completed their basic undergraduate preparation in some field of the biological sciences, with at least two years' work in Zoology. Suitable training in botany, chemistry, mathematics, and physics is also necessary. Students lacking these requirements may be admitted but will be required to complete certain courses which do not give graduate credit.

Candidates for the Master's degree in Zoology will be required (a) to present two credits in Zoology Seminar (Zool 87, 88) and (b) to pass an oral examination covering their general preparation in the field and their graduate and undergraduate courses in the biological sciences. With the permission of the Department Chairman and the prospective Supervisor of the Thesis, a student may elect to submit a thesis in partial fulfillment of the requirements of the Master's degree. The number of thesis credits will be six.

Students who apply for advancement to candidacy for the Ph.D. degree must (a) demonstrate to the satisfaction of the Guidance Committee proficiency in reading zoological literature of two foreign languages, usually French and German; (b) demonstrate to the Doctoral Committee a broad basic knowledge of the field of Zoology and cognate sciences by means of an oral qualifying examination.

51. **PARASITOLOGY.** An introductory course concerned with some of the more important parasites causing diseases of man and animals. Living materials will be used as far as possible. Mr. Bullock. *Prereq.*: Biology 2 and one year of Zoology. 2 lec.; 2 lab.; 4 cr.

55. **MARINE INVERTEBRATE ZOOLOGY.** A survey of the major invertebrate groups with emphasis on the inshore marine fauna. About one fourth of the laboratory time will be devoted to field work with emphasis on natural history and ecological relationships. Mr. Moore and Staff. *Prereq.*: General Zoology. 3 rec.; 3 labs.; 6 cr. (*Offered in Summer only.*)

56. **FRESHWATER AND TERRESTRIAL INVERTEBRATES.** The natural history and taxonomy of the invertebrates of land and freshwater, exclusive of insects, with special reference to those of Eastern North America. *Prereq.*: General Zoology. 2 rec.; 2 lab.; 4 cr. (Alternate years; not offered in 1960-61.)

57. **COMPARATIVE PHYSIOLOGY.** A course designed to study in a comparative manner the functional systems found throughout the animal kingdom. Major emphasis will be placed on the functional or ecological adaptations of the organism to its environment. Mr. Lavoie. *Prereq.*: Zoology 7 and 20 or 59, a year of college physics, and a course in organic chemistry. 3 lec. or rec.; 1 lab.; 4 cr. Formerly Zool. 60.

59. **GENERAL PHYSIOLOGY.** A course designed to study the fundamental physiological properties of the living system. Initial considerations will be

concerned with the plasma membrane and associated membrane phenomena, followed by a consideration of the chemical and physical nature of the living system. The fundamental physiological properties of excitability, contractility, conductivity, metabolism, growth, and reproduction will then be considered. Mr. Wright. *Prereq.*: Zool. 8 or 17, a year of college physics, and a course in organic chemistry. 3 lec. or rec.; 1 lab.; 4 cr. (Alternate years; offered in 1960-61.)

61. GENETICS. A study of the physical basis of inheritance, expression, and interaction of the hereditary units, linkage, and variation. The application of Mendelian principles to plant and animal breeding. Mrs. Richardson. *Prereq.*: Biology 2, or General Botany and Principles of Zoology. 3 lec. or rec.; 3 cr.

62. ADVANCED GENETICS. A study of the recent advances in genetics and cytogenetics. Mrs. Richardson. *Prereq.*: Zoology 61. 2 lec.; 2 lab.; 4 cr.

65. EMBRYOLOGY. A study of the fundamental principles of development. The developmental process from the egg to the formation of the body and the establishment of the principal organs and systems. Mr. Gibson. *Prereq.*: Zoology 7 or 17. 2 lec.; 2 lab.; 4 cr.

66. ELEMENTS OF HISTOLOGY AND MICROTECHNIQUE. A study of the microscopic anatomy of principal tissues and organs of vertebrates with an introduction to general histological technique. Mr. Gibson. *Prereq.*: Comparative or Human Anatomy. 2 lec.; 2 lab.; 4 cr.

77. NATURAL HISTORY AND TAXONOMY OF THE VERTEBRATES. A study of vertebrate animals exclusive of birds; their habits, habitats, life histories with special reference to those occurring in Eastern North America. Techniques of collection, identification, and preservation are included. Mr. Sawyer. *Prereq.*: General Zoology. 3 rec.; 2 lab.; 5 cr.

87, 88. ZOOLOGY SEMINAR. Seminar discussions on current zoological literature conducted each week. Primarily for seniors majoring in Zoology and for graduate students. Graduate students may present no more than 2 credits in Zoology 87, 88 in completing the 30 hours required for a Master's degree. Mr. Moore and staff. *Prereq.*: Permission of the Department Chairman. 1½ hours per week. 1 cr.

97, 98. SPECIAL PROBLEMS. Advanced students may elect a special problem provided they present a detailed outline of the subject and can furnish adequate proof of their ability to carry it out with equipment available. Mr. Moore and staff. *Prereq.*: Permission of the Department Chairman. 1-4 cr.

111, 112. PROBLEMS IN (a) ANIMAL ECOLOGY, (b) EMBRYOLOGY, (c) INVERTEBRATE ZOOLOGY, (d) PARASITOLOGY, (e) PHYSIOLOGY, (f) VERTEBRATE NATURAL HISTORY AND TAXONOMY. This course involves reading, laboratory work, and conferences on special problems approved by the staff. Two copies of a formal report must be filed with the Department Chairman before credit is given for this course. Staff. *Prereq.*: Permission of the Department Chairman. 1-4 cr.

136. ORNITHOLOGY. A study of birds; their identification, migrations, life histories, and economic importance with special reference to those of Eastern North America. This course will meet with Zoology 36. Students are expected to do extra reading and laboratory work. Not open to students who have credit for Zoology 36. Mr. Sawyer. *Prereq.*: Zoology 7. 1 rec.; 2 lab.; 3 cr.

151. **PARASITOLOGY.** An introductory course concerned with some of the more important parasites causing diseases of man and animals. This course will meet with Zoology 51. Students are expected to do extra reading and laboratory work. Not open to students who have credit for Zoology 51. Mr. Bullock. *Prereq.:* 8 hours of Zoology. 2 lec.; 2 lab.; 4 cr.

155. **MARINE INVERTEBRATE ZOOLOGY.** A survey of the major invertebrate groups with emphasis on the inshore marine fauna. About one fourth of the laboratory time will be devoted to field work with emphasis on natural history and ecological relationships. This course will meet with Zoology 55. Students are expected to do extra reading and laboratory work. Not open to students who have credit for Zoology 55. Mr. Moore and staff. *Prereq.:* General Zoology. 3 rec.; 3 labs.; 6 cr. (*Offered in Summer only.*)

156. **FRESHWATER AND TERRESTRIAL INVERTEBRATES.** The natural history and taxonomy of the invertebrates of land and freshwater, exclusive of insects, with special reference to those of Eastern North America. This course will meet with Zoology 56. Students are expected to do extra reading and laboratory work. Not open to students who have credit for Zoology 56. Mr. Moore. *Prereq.:* General Zoology. 2 rec.; 2 lab.; 4 cr. (Alternate years; not offered in 1960-61.)

157. **COMPARATIVE PHYSIOLOGY.** A survey of means whereby animals, both invertebrate and vertebrate, have met the problems of irritability, nutrition, maintenance of a constant internal environment, and reproduction. Mr. Lavoie. *Prereq.:* Biology 2 and one year of Zoology, College Physics, Organic Chemistry. 3 lec.; 1 lab.; 4 cr.

159. **GENERAL PHYSIOLOGY.** A course designed to study the fundamental physiological properties of the living system. Initial considerations will be concerned with the plasma membrane and associated membrane phenomena, followed by a consideration of the chemical and physical nature of the living system. The fundamental physiological properties of excitability, contractility, conductivity, metabolism, growth, and reproduction will then be considered. This course will meet with Zoology 59. Students will be expected to do extra reading and laboratory work. Not open to students who have credit for Zoology 59. Mr. Wright. *Prereq.:* Zool. 8 or 17, a year of college physics, and a course in organic chemistry. 3 lec. or rec.; 1 lab.; 4 cr. (Alternate years; offered in 1960-61.)

162. **ADVANCED GENETICS.** A study of the recent advances in genetics and cytogenetics. This course meets concurrently with Zoology 62, but demands additional reading and laboratory work. Not open to students who have credit for Zoology 62. Mrs. Richardson. *Prereq.:* Zoology 61. 2 lec.; 2 lab.; 4 cr.

177. **NATURAL HISTORY AND TAXONOMY OF THE VERTEBRATES.** A study of vertebrate animals, exclusive of birds; their habits, habitats, life histories with special reference to those occurring in Eastern North America. Techniques of collection, identification, and preservation are included. This course will meet with Zoology 77. Students will be expected to do extra reading and laboratory work. Not open to students who have credit for Zoology 77. Mr. Sawyer. *Prereq.:* Zoology 7. 3 rec.; 2 lab.; 5 cr.

RESEARCH. Open to students who have declared their intention of proceeding to candidacy for the Ph.D. degree.

M. S. THESIS. Open to students who wish to do independent original research. *Prereq.:* Permission of the Department Chairman and the prospective supervisor. 6 cr.

